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MEMOIRS
OF THE
Royal Society;

Being a New ABRIDGMENT of the

Philoſophical Tranſactions.

Giving an ACCOUNT of the Undertakings, Studies, and Labours of the LEARNED and INGENIOUS in many conſiderable Parts of the WORLD; from the firſt Inſtitution of that ILLUSTRIOUS SOCIETY in the Year 1665, to the Year of our LORD 1735 incluſive.

The whole carefully abridg'd from the Originals, and the Order of Time regularly obſerv'd, with a Tranſlation of the LATIN TRACTS, and the Theoretical Parts apply'd to Practical Uſes; alſo an Explanation of the Terms of ART as they occur in the Courſe of the Work; being a Work of general Uſe to the Publick, and worthy the Peruſal of all MATHEMATICIANS, ARTIFICERS, TRADESMEN, &c. for their Improvement, in various Branches of Buſineſs.

By Mr. BADDAM.

Illuſtrated with a great Variety of COPPER PLATES.

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MEMOIRS
OF THE
ROYAL SOCIETY;
Being a New ABRIDGMENT of the
PHILOSOPHICAL TRANSACTIONS.

A Way of making all Sorts of Plants, Trees, Fruits, *&c. grow to an extraordinary Bigneſs.* Philoſophical Tranſactions, N° 116. p. 356.

THE whole ſecret conſiſts in ſowing all ſorts of grains and kernels, in beds of earth, at the very time, when the ſun enters into the vernal equinox, and to take them up, when they are ſtrong enough to be tranſplanted, at the time of the full moon; which time is always to be obſerved, if you would take them up and plant them again: And to know the moment, or very near it, of the equinox, take ſome aſhes of vine-wood, put them into an earthen-pot leaded, or into a very clean pot of the white-earth of *Faenza*, pour upon it common water, or very clear fountain or rain-water from the $\frac{9}{19}$ to the $\frac{11}{21}$ of the ſame, and at the time when the ſun enters into the equinoctial point, you will ſee the aſhes make the water turbid, and then is the time of ſowing your grains, and planting your kernels.

Microſcopical *Obſervations*; *by M.* Leewenhoeck. Phil. Tranſ. N° 117. p. 378.

AFTER drying an optic nerve, and making a tranſverſe ſegment thereof, M. *Leewenhoeck* not only obſerved one hole in it, but ſeveral, which made it reſemble a leathern ſieve; only with this difference, that the holes in the nerve were not round, no more than they were all of the ſame bigneſs, nor ſo regularly poſited, as thoſe in a ſieve.

He obſerved the ſanguineous globules, that make the blood red, were firmer and harder, when his body was much out of order; but afterwards ſofter, when his body was in a good ſtate of health; and he is of opinion, that thoſe ſanguineous globules in a healthy body muſt be very flexible and pliant, to paſs thro' the ſmall capillary veins and arteries; and that, in their paſſage, they change into an oval figure, re-aſſuming their roundneſs, when they come into a greater ſpace; beſides this, he obſerved, in the clear matter of the blood, figures of a quadrangular form, which he ſuppoſes to be ſome ſaline parts.

Optical *Aſſertions concerning the* Rain-bow; *by M.* Fr. Linus. Phil. Tranſ. N° 117. p. 386. *Tranſlated from the* Latin.

I. EACH the ſmalleſt drop of rain, illuminated with the ſun-beams, emits from itſelf a perfect rainbow, not only as to the colours, but alſo as to their order, ſite, and circular figure, very much reſembling that in the heavens.

II. For the ſun-beams entring a drop, and after two refractions, and one reflexion returning again from thence towards the ſun, do eſcape out of the drop all coloured, and endued with the very ſame colours, as red, yellow, green, blue, and purple, which are obſerved in the rainbow.

III. Theſe rays thus coloured, being in rain tranſmitted to the eye from various drops illuminated by the ſun, cauſe the viſion we have of an iris.

IV. There are two rings in each drop, a larger and a ſmaller, endued with diſtinct rainbow colours; the leſſer of which is diſtant from the axis, or ray paſſing thro' the centre of the drop, by about 21°; and the larger by 78°: But the rays incident on the ſmaller ring, are thence reflected upon the greater; from which eſcaping into they air, the are endued with the ſaid rainbow colours.

V. Therefore, theſe colours ariſe from the ſolar beams; but not from them alone, as was hitherto thought, but alſo from the rays of the air itſelf, ſurrounding the ſolar body.

VI. But neither do theſe colours ariſe from all the rays, whether ſolar or aerial, which enter the drop; but only from ſuch as are emitted from the ſolar limb itſelf, and from the air adjacent thereto.

VII. But ſuch rays as are thus tranſmitted from the ſolar limb, and the neighbouring air into the drop, do not all belong to the ſaid colours, nor do they eſcape coloured; but ſuch only, whoſe angle of incidence is neither leſs than 45°, nor greater than 75°.

VIII. Therefore the rainbow colours proceed from the ſolar limb and the adjacent air, yet all the five do not immediately flow thence; but four only, *viz.* red, yellow, blue, and purple; for the green ariſes from a mixture of yellow and blue rays.

IX. Therefore, theſe four colours ariſe from the ſaid limb, but not all from one and the ſame part; but two of them from one part of the limb; and the other two from that directly oppoſite; *viz.* the blue and purple ariſe from the ſuperior limb; and the red and yellow from the inferior.

X. And there ſeems to be no other reaſon of this, *viz.* why from limbs ſo very like, diſſimilar rays ſhould ariſe; but that in one caſe, the aerial limb is above the ſolar; and in the other caſe, the ſolar above the aerial: And this difference ſeems to be ſufficient, becauſe on account of that different ſituation, at one time the ſolar rays may be bent by refraction above the aerial rays; and at other times on the contrary, the aerial above the ſolar.

XI. Therefore theſe colours ariſe by means of the ſaid refracted rays, yet ſo refracted, that by that refraction they are very much crouded together; for all the rays from the 45th degree to the 60th are in the leſſer ring contracted into the ſpace of one degree; into which narrow ſpace, all the rays from the 60th to the 75th degree do concur by retrogradation.

XII. There are as many rainbows at once, as there are ſpectators.

XIII. A ſpectator obſerves at each moment a different rainbow.

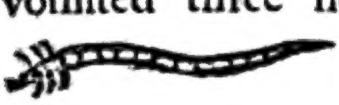
Of Damps; *odd* Worms *diſcharged at the Mouth*, &c. *by Children*; *by Mr.* Jeſſop. Phil. Tranſ. N° 117. p. 391.

THERE are four ſorts of damps; the firſt is the ordinary ſort; the ſigns of its approach are the candles burning orbicularly, the flames leſſening by degrees, till they quite go out, and ſhortneſs of breath; ſuch as eſcape ſwooning, receive no great harm thereby; but thoſe that ſwoon away, and eſcape an abſolute ſuffocation, are, upon their firſt recovery, tormented with violent convulſions; the pain of which, when they begin to recover their ſenſes, cauſes them to cry out exceedingly: The ordinary remedy is to dig a hole in the earth, and lay them on their bellies, with their mouths in it; if that fail, they fill them full of good ale; and if that miſcarry, they conclude their caſe deſperate.

The ſecond ſort of damp is called the peaſe-bloom-damp, becauſe it is ſaid to ſmell like that bloom; it always happens in the ſummer-time; and this damp is obſerv'd in grooves, that are not infeſted with any other; it is not reckoned mortal; but on account thereof, many grooves lie idle for the beſt, and moſt profitable ſeaſon of the year, when the ſubterraneous waters are loweſt: It is ſuppoſed to proceed from the red trefoil-flowers, called honey-ſuckles, with which the lime-ſtone meadows in the peak do much abound.

The third is the moſt extraordinary and moſt peſtilential of all; ſuch as pretend to have ſeen it, for it is viſible, deſcribe it thus; in the higheſt part of the roof of thoſe paſſages, which branch out from the main groove, ſomething round is often ſeen hanging about the bigneſs of a foot-ball, covered with a ſkin of the thickneſs and colour of a cobweb; this, they ſay, if broken by any accident, immediately diſperſes itſelf, and ſuffocates all the company: Therefore, to prevent its ill effects, as ſoon as it is obſerved, by the help of a ſtick and long rope, they break it at a diſtance; after which the place is well purified with fire, before they venture in again: And it is ſaid, that the ſteam, ariſing from the bodies of the miners, and from the candles, aſcends into the higheſt part of the vault, and condenſes there, and in time contracts a film, and at length corrupting, it becomes peſtilential.

The fourth, which they alſo call a damp, is that vapour, which touched by their candle, preſently takes fire, giving a report like a gun, and producing the effects of lightning.

A girl in *Sheffield*, about eight months old, was taken with violent vomiting fits, which continued for about a week, and made her ſo weak, that her parents began to deſpair of her recovery; upon giving her about a point of wormwood-ale, ſhe vomited three hexapods, the bigneſs and ſhape of this figure,  all very active and nimble.

As to the vomiting of worms, Dr. *Liſter* obſerves, that a boy of nine years of age was afflicted with great pain in his ſtomach, and continual vomitings; upon giving him a powder, wherein was a ſmall quantity of *Mercurius Dulcis*, he vomited up ſeveral odd worms, which were perfect caterpillars with 14 feet, ſomething more than an inch in length, and of the thickneſs of a duck's quill, with thin hair, or rather naked, with brown wings and a black head; and he thinks they would in time, if the place did not hinder, become *Chryſales* and be changed into moths, as thoſe mentioned by Mr. *Jeſſop* would have become beetles.

Mr. *Jeſſop* owns, that to account for the phænomena called fairy-circles has very often puzzled him; he obſerved many of them, and thoſe of two ſorts; one ſort bare, of 7 or 8 yards diameter, forming a round path ſomething more than a foot broad, with green graſs in the middle; the others like them, but of ſeveral bigneſſes, and encompaſſed with a circumference of graſs, about the ſame breadth, much freſher and greener than that in the middle; but his friend Mr. *Walker* ſatisfied him on this head from his own experience, for he, walking abroad after a ſtorm of thunder and lightning, obſerved a round circle, of about four or five yards diameter, whoſe rim was about a foot broad, newly burnt bare, as appeared from the colour and brittleneſs of the graſs-roots.

Obſervations in Scotland; *by Sir* Geo. Mackenzie. Phil. Tranſ. N° 117. p. 396.

ONE of the moſt ordinary ſoils for barley in the north of *Scotland*, is an earth dug and mixed with the dung of cattle; in a place near *Tarbat* is a plot of ground, leſs than an acre, out of which earth had been dug for many years; in two years time it will grow up again, and fill the excavated place; ſo that it continually ſupplies ſoil for the adjacent land; it is a ſtiff clayiſh earth, of a dark colour, and moiſt: Nothing makes land give greater increaſe of barley than ſea-wrack or ſea-weed; but ſuch lands as are often accuſtomed to this manure, yield but bad oats, and in ſmall quantities; and the huſks both of the barley and oats are thicker than thoſe of other lands, and they have a greater mixture of darnel.

The increaſe in ſome places in the *Iſles* is almoſt incredible, conſidering the climate and ſoil, for ſome will ordinarily yield ſixteen or eighteen fold; and moſt of theſe lands are of a very ſandy ſoil, and only manured with ſea-wrack; Sir *George* himſelf had a piece of land in *Lockbroom* pariſh, that yielded continually every year plentiful crops of barley, without one load of manure, or any kind of addition made to it; and this it had done for time immemorial; and yet the ground did not grow leſs, nor was it exhauſted by yielding ſuch plenty of corn and ſtraw: There are alſo ſome fields, which appear to be nothing but a collection of ſmall pebbles, yet they yield abundance of good corn, eſpecially barley.

In the highlands when they want ink, they take the root of the *Iris paluſtris lutea* (yellow water flower-de-luce) and infuſe it for 24 hours in clear fountain-water, and others boil it a little; then they take a rough white pebble, and rub it continually in the water on a knife, or a piece of clean ſteel; and in leſs than an hour's time, the water will become very black, and tolerable good ink.

It is alledged, that when deer are wounded, they lie on a certain herb, which grows plentifully in the foreſts, whoſe virtue is ſuch that it ſtaunches the bleeding and heals the wound, it is the *Aſphodelus Lancaſtriæ verus* of *Johnſton*, or the *Lancaſhire Aſphodil*; Sir *George* took a quantiry of it, and made it into a ſalve with wax and butter; but he found it to heal too quick, ſo that he could not venture to uſe it in any deep wound; but in ſuperficial ſcars it has a very ſudden operation.

It is common to find *Molucca-beans* faſtened to their ſtalks, on the ſhore of the *Lewes* and other weſtern iſles, which the common people ſuppoſe to be ſea-tangles, a kind of ſea-weed; it is obſervable that the kernels of theſe nuts will be freſh and ſound; of the bean-huſk ſnuff-boxes are made.

Obſervations made at Barbadoes; *by Dr.* Tho. Towns. Phil. Tranſ. N° 117. p. 399.

AT *Barbadoes*, their general draught of wine is from *Madera*, which, contrary to all other wines, will not bear a cool cellar; neither do *French* or *Rheniſh* wines keep or agree well, if drank as conſtantly as in *England*.

This iſland is very temperate; and the ſun, notwithſtanding his neighbourhood, is very gentle, being fanned with a conſtant gale from the eaſt.

Purſlane is very common, and even troubleſome to the planter; it eats with oil and vinegar as well as that of the *Engliſh* gardens; *Sonchus*, *Lens Paluſtris*, and melilot are common here, only the branches of the latter are not ſo erect as that of *Engliſh* growth.

All their ſprings are near the ſea, ſo that thoſe who live up the country have no benefit by them; they formerly made ponds to receive the rain, which anſwered well enough, being kept cool by a broad-leaved weed, and ducks-weed, that overgrow moſt ponds; but now every ſugar-plantation hath a well that affords very good water.

The ſoil is fertile, tho' not above a foot or two deep, upon a white and ſpungy lime-ſtone rock, which affords good quarries for building; every dwelling-houſe with the ſugar-work, and out-houſes, looks like a handſome town, being built of ſtone, and covered with pan tile or ſlate, brought hither as balaſt of ſhips, as are likewiſe ſea-coal for forges; the whole iſland appears in a manner like a ſcattered town, which with the perpetual green fields and woods, makes a fine proſpect.

The blood of negroes is almoſt as black as their ſkin; ſo that their blackneſs is probably inherent in them, and not cauſed by the ſcorching of the ſun, eſpecially, ſince other animals here have as florid blood as thoſe in a cold climate.

A ſummary Relation of the Diſcoveries about the North-eaſt *Paſſage.* Phil. Tranſ. N° 118. p. 417.

IT is ſufficiently known how ſtudiouſly the States of the *United Provinces* have laboured to encourage thoſe, who ſhould firſt diſcover a more compendious and ſhorter paſſage by the north to *China*, *Japan* and other eaſtern countries: But thoſe, who firſt ventured upon this enterpriſe, found by ſad experience, that the event did not anſwer their hopes. Thoſe, who immediately ſucceeded them in that adventure, were not much more ſucceſsful; for treading the ſame ſteps with the former, they were involved in the ſame difficulties, entertaining a fond opinion, that that part of the ſea, between *Nova Zembla*, and the continent of *Tartary*, had been paſſable, and that they might have ſailed that way to *China*; but it is now generally known that *Nova Zembla* is no iſland, but a part of *Tartary*, to which it is annexed on the eaſt by a large neck of land; that that arm of the ſea, into which there is a paſſage thro' the *Weigat*'s ſtraights, is not really ſea, but a lake of freſh water; the great number of rivers, which empty themſelves into this gulf, cauſe this freſhneſs; ſo that it is nothing extraordinary, if, in winter, theſe waters be ſtrongly frozen: Nor is it to be wondered at, that *William Barentz*, othewiſe a ſkilful ſeaman, was unſucceſsful in his navigation, who paſſed along the coaſt of *Nova Zembla*, as far as the 77th degree of N. Lat. for it is well known that moſt of thoſe northern coaſts are frozen up for many leagues; tho' not ſo in the open ſea; no nor under the pole itſelf, unleſs by accident, as when, on the approach of the ſummer, the ice that is within 40 or 50 leagues of the ſhore, breaks off from the land, and floats up and down in the ſea: Theſe prodigious flakes of ice were the principal obſtruction in the courſe of thoſe, who ſailed a little more northerly: Some merchants at *Amſterdam* attempted thoſe ſeas with much better ſucceſs than the former, having advanced as far as the 79th or 80th degree of N. Lat. and paſſed above 100 leagues to the eaſt of *Nova Zembla*; upon their return they petitioned the States General to grant them the navigation of the northern and eaſtern ſeas not yet diſcovered; but the governours of the *Eaſt-India* company, being ſenſible how nearly this concerned them, preſented a counter-petition, that the petition of the ſaid merchants might be referred to them; and they finding their petition thus croſſed, addreſſed themſelves to the king of *Denmark*, who immediately granted their demands; under his protection they equipped two or three ſhips; upon which the governours of the *Eaſt-India* company raiſed a conſiderable ſum of money, and eaſily perſuaded the mariners to deſiſt from ſo dangerous a voyage, as they repreſented it; and that the merchants might have no juſt cauſe to complain of the ſaid company, the mariners went to ſea; but neglecting the directions and orders of thoſe merchants, they ſteered their courſe directly for *Spitzberg*, took in their lading of fiſh, and returned home: Upon this the *Eaſt-India* company omitted nothing, to find out a paſſage thro' the north-eaſt ſea for thoſe that were to return into *Europe* from the *Eaſt Indies*; and there was then much talk of the gulf of *Anian*, by which a paſſage was ſaid to be open into the ſea of *Tartary*; and they had ſome hints from the people of *Japan*, and the *Portugueze* about the country of *Jezzo*, which lay above *Japan*; but not ſatisfied with a bare relation, in the years 1652 and 53, they ſent out ſome ſkilful perſons to diſcover thoſe coaſts, who paſſing beyond *Japan*, in the 50th degree of N. Lat. arrived on the coaſt of *Jezzo*, where they fell into a narrow ſea, yet broad and convenient enough to bring them into the northern ocean; they called the oppoſite ſhores *Het Compagnie Land*, and an iſland ſituated in the middle of the gulf, *Het Staten Eyland*. Whether *Jezzo* be annexed to *Japan* or not, the inhabitants of both countries doubt, becauſe vaſt and inacceſſible mountains interpoſe which hinder the communication; nor does it appear, whether *Jezzo* be a part of *Tartary*, or divided from it by an arm of the ſea: The *Chineſe* affirm, that *Tartary* runs 300 leagues to the eaſt beyond their famous wall; ſo that the country of *Jezzo* and *Japan* may ſeem to be annexed to *Tartary*; but thoſe of *Jezzo* ſay, that there runs an arm of the ſea betwixt them and *Tartary*; which may ſeem to receive ſome confirmation from the *Dutch*, who ſuffered ſhipwreck on *Corea*, a peninſula of *China*, where they ſaw a whale ſtuck in its back with a harping-iron of *Gaſcony*; therefore it is probable, that this whale paſſed from *Spitzberg* thro' the neareſt arm of the ſea, rather than thro' the more remote.

After the experiments, made by the governours of the *Eaſt-India* company in 52 and 53, they reſolved to proceed no further in the diſcovery; both becauſe the emperor of *Japan* interdicted the navigation of foreigners to *Jezzo*, in regard, as they ſay, of the vaſt tribute, which he annually raiſes on the ſilver-mines there; and becauſe they thought it might little conduce to their advantage to have this compendious way of navigation diſcovered; and therefore, they thought fit to prohibit all farther ſearch into the navigation of *Jezzo*, and the adjacent countries; for which very reaſon, they have alſo endeavoured to conceal their *Auſtral* plantations.

It now remains to enquire by what courſe, and in what ſeaſon of the year this voyage is to be undertaken; it is not to be doubted, but the ſtraight betwixt *Spitzberg* and *Nova Zembla* may be paſſed; and the courſe be directed to 78, 79, and 80° of North Latitude; if any ſhall proceed farther in the ſame courſe, he will find the paſſage ſhorter; for drawing a line from our ſeas thro' the 78 or 79° of Latitude, to the *Streight* of *Jezzo*, it will be nearly a ſtraight line; but if from the ſame degree of latitude, after paſſing *Nova Zembla*, any would chuſe to ſteer towards the coaſt of *Tartary*, he would find his courſe ſomething longer, but perhaps ſafer and better: As to the time of the year wherein this navigation ſhould be undertaken; it may be in the beginning of the ſpring, and in the month of *March*, when the ſeas and winds are owned to be favourable to thoſe that ſail to *Spitzberg*, and places near the pole, and all that courſe may be run from theſe parts in 12 or 13 days; but when they have paſſed ſo far, if any man would deſign to ſail to the *Streights* of *Jezzo*, he muſt ſteer his courſe towards the ſouth; but then theſe motions of the winds and ſeas, which were favourable to thoſe that ſailed northward, will be contrary to thoſe who ſtand to the ſouth; and they may long enough expect northern gales, which ſeldom blow till towards the latter end of ſummer, *viz.* in the month of *Auguſt*; if therefore, any man would contrive to diſpatch his voyage in the ſhorteſt time, it is ſafeſt to make choice of that time of the year, wherein he might ſooneſt make *Spitzberg* and return in time, which might be in the beginning of ſummer; yet it would be ſafer to ſet out ſooner, if the wind permit: All near approach to the coaſts and iſlands, for fear of the ice, ſhould, as much as poſſible be avoided, keeping always in the open ſeas, which are leaſt infeſted therewith, and in which the colds are much more moderate; for experience ſufficiently ſhews, that whole large ſeas are never known to be frozen, only the ſea-coaſts, from the quantity of freſh water that runs into the ocean, and the ſnow melted in it; and the ſame experience ſhews, that there is not that danger from the rolling ice, as is vulgarly apprehended, eſpecially in ſeas not ſubject to violent ſtorms, and in the 6th or rather the 8th month of the year: When the nature of this ſea, and of its ſeveral ſtraights ſhall be more perfectly diſcovered, it is not to be doubted, but that the whole voyage to *Japan* may be performed in 5 or 6 weeks at moſt; but in caſe it ſhould happen, that the ſhips ſhould be forced to winter there, this might be done without much danger, providing they did not follow the unadviſed example of the *Dutch*; who being neceſſitated to winter in the moſt northerly climates, built themſelves huts of thin boards on the higheſt mountains; whereas they ſhould have ſunk their houſes under ground, and heaped much earth over them.

Pneumatical *Experiments*; *by M.* Huygens, *and M.* Papin. Phil. Tranſ. N° 119. p. 443.

IN order to mix together ſeveral liquors by means of the air-pump, two ſmall glaſſes were uſed, the one of which could enter into the other, and the leaſt of them was faſtened to the hook of an iron-wire, paſſed thro' a ſmall hole on the top of the receiver, and tied cloſe about with an eel-ſkin, and the larger glaſs ſet under it; and the ſaid wire was ſo ordered, that theſe two glaſſes were a little diſtant from each other, till the receiver was exhauſted; upon which, by means of the iron-wire, the ſmaller glaſs was let down into the larger, till the liquors, they contained, mixed themſelves: Thus, ſome *Aqua-fortis* was poured into the upper glaſs, and ſpirit of wine into the lower, and the receiver was ſo well exhauſted of air, that the ſpirit of wine boiled up with large bubbles, and the *Aqua-fortis* emitted ſome ſmall bubbles; after both the liquors had been well purged of air, the upper glaſs was ſunk into the lower, ſo that the ſpirit of wine was mingled with the *Aqua-fortis*, when there was ſtill obſerved a very conſiderable ebullition: Now, in order to diſcover, whether the *Aqua-fortis* imparted to the ſpirit of wine ſome new vigour, or force, to make it bubble; ſome *Aqua-fortis*, with ſpirit of wine, was mixed without the receiver, the quantity of the former being ſomewhat more than that of the latter; putting this mixture *in Vacuo*, inſtead of boiling up more ſtrongly than the ſpirit of wine, as it was thought it would have done, it only caſt up ſome few bubbles; which ſhewed, that the ebullition of the mixture *in Vacuo*, is of the ſame nature with that of acids and alcali's; for in the inſtant of mixture, they make great ebullitions, but ſoon after they deſtroy each other, and loſe the properties they had before; it is alſo probable, that the *Aqua-fortis* and ſpirit of wine would boil always, when mixed, only the preſſure of the air hinders the ebullition from being ſenſible, which, when removed, becomes apparent: It was alſo obſerved, that common ſalt and ſpirit of wine mixed *in Vacuo* make an ebullition, and a ſolution of ſalt-petre, a greater ſtill: It is obſervable, that making a mixture of common water and *Aqua Vitæ*, and putting it *in Vacuo*, it bubbles up very well, tho' the former be in greater quantity than the latter; whereas, a mixture of *Aqua-fortis* and *Aqua Vitæ* did not there bubble at all: In order to know whether theſe ebullitions produced any new air, a gage was put into the receiver, which is a glaſs tube filled either with water freed of air, or with mercury, four inches long; and it was obſerved, that when the liquors were mixed together, the water in the gage roſe very nimbly to the top; and then exhauſting this new air, the gage-water was made to ſubſide again gradually; and thus it was found, that all theſe kinds of ebullition generate an air which expands itſelf like common air: It ſeems ſomething remarkable, that the air made by theſe ebullitions, is not of the ſame nature; for it has been found experimentally, that the air, formed by the mixture of *Aqua-fortis* and copper, remains always air, and always ſuſtains the water in the glaſs, at that height to which it raiſed it; but on the contrary, the air produced by the mixture of oil of tartar, and oil of vitriol, almoſt vaniſhes of itſelf in 24 hours: Upon mixing equal parts of *Aqua-fortis* and *Aqua Vitæ*, and putting two equal quantities of this mixture into two ſmall glaſſes with two equal pieces of iron, one to each, and including one of the glaſſes *in Vacuo*, there was ſeen a very great ebullition, and the liquor became black, whilſt the other glaſs that was not put into the receiver made no ebullition, but remained always tranſparent, or rather white than black; after theſe glaſſes had ſtood 12 hours, the iron in the glaſs *in Vacuo* was almoſt all diſſolved, whereas the other was very little diminiſhed; this experiment ſucceeds the quite contrary way, when made with

Aqua fortis alone and copper; for then the ſolution is leſs *in Vacuo* than out of it: Oil of olives with vinegar, or ſpirit of wine makes no ebullition either *in Vacuo* or out of it, in the inſtant of mixing; but mixing together out of the receiver oil of olives, vinegar and ſpirit of wine, and putting this mixture *in Vacuo*, it did not boil up ſo ſoon, as when there was no oil; but then the bubbles, which it afterwards made, were larger, and they began to appear again at times, ſo that ſome of them were ſeen a quarter of an hour after the receiver had been exhauſted; poſſibly this may be owing to the oil ſwimming a-top, which detains the more volatile parts of the ſpirit of wine, that would otherwiſe fly away immediately on exhauſting the air, and at the ſame time hinders the ſurface of the liquor below from eaſily riſing into bubbles; becauſe, to make them do ſo, the parts of the oil that ſtick cloſe to each other, muſt be ſeparated; when therefore the volatile parts are collected in a ſufficient quantity, able to ſurmount the reſiſtance of the oil, they iſſue out with greater violence, than if nothing had detained them: All the ebullitions hitherto ſpoken of, are greater *in Vacuo* than in the open air, but not ſo with lime; for taking two equal glaſſes with two equal quantities of water, and putting the one of them *in Vacuo*, the other in the open air, it appeared that the former emitted ſome large bubbles, but fewer than the latter; the one in the receiver had the conſiſtence of dirt, whereas the other had that of ſlacked lime; which may be owing to the exhaling of the volatile ſalts of the lime in exhauſting the receiver,

Of Damps in Mines; *by Mr.* Jeſſop. Phil. Tranſ. N° 119. p. 553.

DAMPS are generally obſerved to come about the latter end of *May*, and to continue during the heat of ſummer; and at that ſeaſon they are moſt violent in mines infeſted with damps all the year long: Damps are ſeldom obſerved to take fire of themſelves, tho' in ſome places they have been kindled by the motion of the ſled, in which they draw their coals: Damps are generally held to be heavier than the air: Upon the breaking of the fulminating damp, there proceeds a dark ſmoak of the ſmell and colour of that from gun-powder: Some damps are viſible and others inviſible: Other damps will quite extinguiſh fires let down into them, tho' never ſo many, nor ſo great; and fire is obſerved to be ſo far from curing, that it often creates damps in places not othewiſe obnoxious to them; it is true fire proves a preſent remedy, if the circulation of the air be promoted by it, otherwiſe they do hurt; and grooves where rocks are broken with great fires, are ſeldom free from damps: Damps are common both in wet and dry ground; ſuch are ſuppoſed to be the moſt peſtilential and to kill moſt ſuddenly, which are in grooves that have ſtood ſtill for many years, eſpecially if they have had formerly great fires in them: The general opinion of the workmen is, that there are ſome damps, which kill by reaſon of the noiſome ſteam, and others merely for want of air; which latter opinion is diſallowed of by the more experienc'd; for they ſuppoſe that no groove wants air, be it ever ſo deep; but the air ſtagnating, and in a little time being filled with the vapours ariſing from the bodies of men, and with the ſteams of candles, is ſoon rendred unfit for reſpiration; and this they take to be the moſt frequent cauſe of ordinary damps: Damps will often follow the water, eſpecially the fiery ſort.

Experiments about the weakened Spring, *and ſome unobſerved effects of the* Air; *by Mr.* Boyle. Phil. Tranſ. N° 120. p. 467.

UPON putting filings of crude copper into a cryſtalline glaſs of a conical figure, into which was poured ſome ſtrong ſpirit of ſalt, to the height of about a finger's breadth above the filings, and then ſtopping the veſſel with a glaſs ſtopple, it continued unmoved in a window for ſome days, till the liquor had both obtained a high and darkiſh brown colour, by the ſolution of ſome of the copper, and loſt that colour again, becoming as clear as common water; and then taking out the ſtopple, without ſhaking the liquor, the upper ſurface thereof did in a few minutes reſume its darkiſh brown colour, which penetrating ſtill deeper, in about ¼ of an hour, the whole body of the liquor appeared to be likewiſe tinged; the conical glaſs being again well ſtopped, the *Menſtruum* did again in a few days loſe its tincture; but regained it as before, upon taking out the ſtopple; keeping the glaſs in the ſame place for a month or two, it was obſerved the liquor would no more grow clear.

Having taken another conical glaſs, wherein the liquor was grown clearer than is uſual, the ſtopple was taken out, and it continued unſtopt for about half an hour, but the liquor was not obſerved to have acquired any colour, not even at the top; but putting in the ſtopple, and leaving it thus for two or three hours, it acquired a faint colour tending to a green; wherefore, taking out the ſtopple again, and continuing it unſtopped for 20 or 24 hours, it had not acquired the wonted dark colour, being only arrived at a green, deep enough, but neither true, nor very tranſparent.

Some ſtrong ſpirit of ſalt being kept upon filings of copper till the ſolution was become of a dark brown colour, and about three ſpoonfuls thereof being put into a receiver *in Vacuo* for about half a year, it ſtill retained its colour; but the veſſel being opened, and the external air admitted, the ſolution was turned in about an hour into a fine tranſparent green, tho' there appeared no precipitation by any ſediment.

Upon putting into a conical glaſs ſome filings of copper, and a convenient quantity of ſpirit of ſalt, after ſeveral weeks it loſt its muddy tincture, and appeared like common water; upon unſtopping the glaſs, it was obſerved that in ſome hours the operation of the air upon the liquor was ſcarce ſenſible; and in 24 hours, the *Menſtruum* did not acquire its former colour exactly, but a ſomewhat fainter and moderately tranſparent green; ſo that this tinged *Menſtruum*, as it had been very ſlow in loſing its colour, ſo it did but leiſurely and imperfectly reſume it.

Some filings of copper with a mercurial gage were put into a conical glaſs, fitted with a ſtopple, and a rectification of fermented urine was poured upon them, to the height of an inch or better; then carefully ſtopping the glaſs, ſeveral hours after, the mercury in the ſealed leg was conſiderably depreſſed; and gently drawing out the ſtopple, to let in the air, it was obſerved to have a manifeſt effect on the mercury.

On a proper quantity of clean filings of good copper ſtrong ſpirit of fermented, or rather, putrefied urine was poured, to the height of an inch above the copper; and letting down into it a mercurial gage, ſo that it leaned on the bottom and ſide of the glaſs, it was cloſed with a ſtopple, and ſet in a quiet and lightſome place, obſerving at what point the quickſilver ſtood in the open leg of the gage; after this, ſuffering the *Menſtruum* to work on the filings, which it did very ſlowly and quietly, it acquired by degrees a very agreeable blue colour; and the glaſs being kept quiet in the ſame place for two or three days longer, the liquor began to loſe of the intenſeneſs of its colour, which by degrees grew fainter and fainter, till at the end of three or four days, the liquor was become very pale; upon taking out the ſtopple, in four or five minutes, if not leſs, the upper part of the liquor, contiguous to the air, acquired a fine blue colour, which deſcended deeper and deeper; ſo that in leſs than a quarter of an hour from the firſt unſtopping of the phial, the liquor was become of a rich blue colour, and in about a few minutes more it turned opake; and carefully cloſing the phial with the ſame ſtopple as before, in two or three days the liquor began to loſe of its colour: In moſt of theſe experiments, Mr. *Boyle* forbore to ſhake the glaſs, leſt it ſhould be ſuſpected, that the agitation of the liquor might have raiſed ſome fine powder, that might be ſuppoſed to be precipitated from the tincture, and thus mixed with the liquor again, reſtore it to its former colour.

Upon covering the bottom of a conical glaſs with a convenient quantity of filings of good copper, and pouring upon them as much ſtrong ſpirit of ſal-armoniac as ſerved to ſwim about a finger's breadth above them; and letting down a mercurial gage, and proceeding in all reſpects, as in the foregoing experiment; the filings acquired, without any ebullition, an agreeable blue colour; and for two or three days together, the mercury in the ſealed leg of the gage, ſlowly deſcended to about $\frac{1}{4}$ of an inch lower than at firſt; by which it appeared, that the ſpring of the air contained in the cavity of the glaſs, and communicating with that in the open leg of the gage, was weakened in compariſon of that in the ſealed leg.

Upon putting a mercurial gage into a conical glaſs, whoſe bottom was covered with beaten coral, ſome ſpirit of wine was poured into it, and then the glaſs ſtopple cloſing the neck exactly, on the working of the menſtruum, a great number of bubbles were produced, which ſucceſſively broke in the cavity of the veſſel, and their acceſſion compreſſed the impriſoned air in the cloſed leg of the gage three diviſions; but in a few hours after, the compreſſion of this new generated air became manifeſtly fainter, and the impriſoned gage-air drove down the mercury again, till it was depreſſed within one diviſion of its firſt ſtation; ſo that in this operation, there ſeemed to have been a double compreſſive power; the one tranſient, and from the briſk agitation of the exhalations; the other durable, and from the aerial or ſpringy particles, either produced, or diſentangled by the action of the ſpirit of vinegar upon the coral.

Upon putting a conſiderable quantity of ſpirit of vinegar upon minium, it continued ſeveral days without any ſenſible depreſſion of the mercury in either leg; nor did there appear any change in the gage, upon removing the ſtopple; tho' it was evident by its ſweetneſs, that it had made a ſolution of a conſiderable part of the minium.

Putting ſome filings of copper into a phial, that held two or three ounces of water, and pouring on them ſtrong ſpirit of ſal-armoniac made without quick-lime, till the liquor reached near an inch above them; in four days, it had acquired a deep blue tincture; but loſt it afterwards ſo much, that it was become almoſt pale like common water; upon unſtopping the phial, in leſs than a minute it acquired a deep blue tincture on its ſurface, the depth of $\frac{1}{8}$ of an inch; and in 4 or 5 minutes more, the whole liquor became of the ſame colour; and ſtopping the phial again, it did not loſe its colour in 9 days.

Putting into a round phial, that held 8 ounces of water, filings of copper, and the mercurial gage, and pouring on the metal ſtrong ſpirit of ſal-armoniac, to a pretty height in the phial; after which, it was hermetically ſealed, and ſet in a ſouth window, where it ſoon acquired a deep blue tincture; in 12 days, the liquor became diluted and pale like water; and in all this time, the mercury in the open leg appeared to be impelled upwards; upon breaking off the hermetic ſeal after 9 o'clock at night, there was a noiſe produced, and the mercury in the ſhorter and cloſed leg was briſkly driven upwards near $\frac{1}{8}$ of an inch; and tho' the orifice that admitted the air could not receive a middle-ſized pea, yet in a minute and a half, the ſurface of the liquor held between the eye and the candle, appeared to have put on a very lovely and fair colour, reaching a quarter of an inch downwards; ſo that the phial ſeemed to contain two very different liquors ſwimming on each other; and in 5 minutes more, the whole liquor had attained a rich blue colour.

Pneumatical *Experiments on* Plants; *by M.* Huygens, *and M.* Papin. Phil. Tranſ. N° 120. p. 477.

UPON paſſing a ſprig of balm thro' the hole on the top of the receiver, with the roots without the receiver, and the top within it; then cloſing the hole with cement, the exhauſted receiver, was thus taken away; the edge of the receiver was well ground, ſo as to touch exactly a glaſs plate, which had alſo been ſmoothly ground to ſerve for a lid to it; and ſpreading a piece of wet lamb-ſkin over the plate, and thus applying it to the engine, the receiver was ſet over it; but in one place there was a hail-ſhot of lead, which hindered the receiver from being exactly applied to its cover, that ſo the air might more freely get out;

and afterwards, covering all with another large receiver, the pump was plied; after it was well exhauſted, the engine was ſhook in ſuch a manner, that the ſmall receiver fell off from the hail-ſhot, and ſtood every where cloſe to the ſkin, expanded over the cover of the glaſs-plate; then admitting the air into the great receiver, and this air preſſing on the ſmall one, kept it ſo cloſely faſtened to its cover, that it was impoſſible to ſever them: Having taken away the ſmall exhauſted receiver, with the plant half ſhut up therein; the whole was put into a great glaſs filled with water, with the root downwards, and ſmall water drops were formed upon the leaves *in Vacuo*; it continued 10 days in this condition, and in that time about two ſpoonfuls of water got into the receiver, which in all appearance had been preſſed thro' the plant: After this, in order to know, whether any air had been formed there, the receiver was replaced upon the engine, and whelming a larger upon it, there was but very little air generated in the ſmall one, becauſe the great receiver was almoſt exhauſted, before the air included in the ſmall one could liſt it up; but at laſt it did raiſe it, and inclining the engine to one ſide, that the ſmall receiver might not be applied to its cover on the re-entring of the air; and in this manner, both the receivers were fitted in the ſame time: The leaves were not withered, tho' they were not grown, only in the middle their colour was a little changed, and they ſmelled a little ſouriſh; but next morning the plant was quite ſpoiled: It may be ſuppoſed, that the preſſure of the air had made the water enter into this plant with ſuch violence, as to have ſpoiled the leaves in the middle, where they were moſt tender; tho' the water ſtill keeping the leaves extended, they withered not; but when the air came to act upon them, the parts of the plant which had ſuffered ſo much, were ſoon corrupted by it.

This experiment was made the contrary way; that is, with the leaves in the air, and the roots in a bottle of water *in Vacuo*; and immediately air-bubbles were obſerved to iſſue out of the roots; and putting water upon the leaves, in order to diſcover, whether this air came from thence; ſoon after, theſe bubbles began to ceaſe, and removing the water wherein the leaves were, the bubbles began to iſſue at the roots as before, for 24 hours; but in a ſmall quantity, till at length they quite ceaſed: During theſe 24 hours, the roots did lengthen about four lines, which is a little leſs than they ordinarily do in the air: The plant was kept in this condition for four days on the engine, obſerving from time to time to exhauſt the air that entred by the leaves; and then it began to wither, and the roots did no longer ſhoot.

Upon putting two twigs of balm into ſeparate phials full of water, in 5 days they both ſhot roots; including *in Vacuo* the one with the longeſt roots, without taking it out of its phial; at the end of 3 days, obſerving that it was withered *in Vacuo*, it was taken out, and the phials were changed, in order to obſerve, whether that which remained in the air, and throve very well in common water, would alſo thrive in water freed of air; and whether that which was withered *in Vacuo* would revive in common water, and in air; in 4 days the twig that had been *in Vacuo* was quite ſpoiled, and the other ſtill verdant, but not thriving; and it was obſerved not to begin to ſhoot in water freed of air, till 10 days after it had been put in.

In order to know, whether water purged of air were leſs fit than common water to make plants vegetate; two phials were filled, the one with purged, the other with common water, and putting a twig of balm in each, they were both left in the air; and the twig in common water ſhot in 6 days, and the other in 10 days after it had been put in.

Having repeated this experiment, the twig in the water, freed of air, begun to ſhoot the 3d day, and the other in common water, the 6th day as before; but it was remarkable, that the twig in the purged water ſhot but one root, which grew very long; and on the 9th day only it began to ſhoot another, which lengthened but one line in 2 days; whereas the twig in common water had then 9 or 10 roots, and all very long, lengthening 5 lines or more a-day: Altho' this experiment appeared at firſt contrary to the preceeding, yet it ſtill confirmed the notion, that air mixed in common water ſerves for vegetation.

After this, ſome experiments were made on firmer plants, and a green piece of ſallow-wood was put part in air and part *in Vacuo*, as deſcribed above; upon putting into water that part which was in the air, the water preſently began to mount, and to paſs thro' the middle of the wood, and inceſſantly formed bubbles in the receiver, for the ſpace of 24 hours, which was nothing more than the water paſſing thro' the wood, in part changed into air; for making the ſame experiment with a piece of buff, the water mounted and paſſed thro' it, but formed no bubbles: Mean time, if there be valves in wood, they muſt needs be unable to reſiſt the preſſure of the air; for the water paſſes both thro' ſallows and elms with the ſame eaſe, what end ſoever is put *in Vacuo:* Having inſerted *in Vacuo* the upper end of a ſmall elm-branch, and the lower end in air, and drenching this latter in water, it was a full hour before there appeared one drop of water on the elm-leaves *in Vacuo*, whereas on the balm-leaves the drops appeared preſently; which may be owing to the firmneſs of the elm; but it is hard to account, why water paſſing thro' wood ſhould form bubbles, and thro' leaves nothing but drops: Having inverted the experiment, that is, putting the leaves in the water without the receiver, and the lower end of the branch in *Vacuo*, nothing appeared in two hours time; upon cutting a little of the upper end of the branch, which was very tender, a little moiſture appeared at the end *in Vacuo*, without any bubble of air; after this, cutting the branch a little lower, there was formed one drop of water at the end *in Vacuo*, but it fell not; and cutting it a little more, the drop of water fell down *in Vacuo*; this ſhews, that they were not the valves of the plant that hindred the water from paſſing, whilſt the branch was entire, but rather the great tenderneſs of the leaves, ſuffering themſelves to be compreſſed by the air, whereby the water could not inſinuate itſelf between their pores.

A Continuation of the Pneumatical Experiments; *by M.* Huygens *and M.* Papin. Phil Tranſ. N° 121. p. 492.

UPON including an apple, which had a little ſpeck of rottenneſs with ſome water in a receiver, thereby to promote its corruption, in caſe any ſhould happen; no change of that nature was obſerved therein.

Upon putting into a receiver two noſegays of roſes, one ſuſpended at the top, the other with its tail in a ſmall veſſel of water, together with a gage four inches long; in two days the roſes were a little withered, and the water already riſen to eight or ten lines near the top of the gage; and after that, the changes of theſe flowers became ſtill leſs; the roſes in the water were as much withered as the others, and as ſoon; other roſes that had been included at the ſame time, but with air, became mouldy in leſs than eight days: At another time a ſingle roſe button was included in a ſmall glaſs, in order to diſcover, whether it would retain its ſcent; after 15 days, it looked ſomewhat leſs freſh, but was not at all withered, and it ſtill retained its ſcent, tho' in leſs than two hours after taking it out, it loſt both colour and ſmell; its leaves did not appear moiſt *in Vacuo*, tho' they did ſo, as ſoon as they were in the air; whence it appears that leaves are ſo many ſpunges, which diſcharge their humidity by the preſſure of the air: Some gilliflowers put into the receiver, were but little changed, only they looked as if they had been dipped in water: Included ſtrawberries kept good, only they became a little ſourifh, and yielded a little water: Included cherries were all burſt except two; in two days more, their colour was ſomewhat changed, and the two, that remained whole, were now burſt; after this no other change was obſerved in them: A glaſs full of included cherries and currants, yielded ſo much air as to raiſe the glaſs: Having put three pears, of that ſort called *Rouſſeletes*, into a glaſs, that could hold no more, they raiſed the glaſs in five days, and were not changed, only one of them was a little ſofter: Upon putting a peach with a gage into an exhauſted glaſs, in ſix hours the mercury was riſen an inch; but it was the 13th day before the glaſs was lifted up, after which it became rotten in a little time: Included bread yielded no air in a whole month: Roaſted mutton, included with a gage, yielded no air in four days; but in ſix weeks after the mercury was riſen to the middle of the gage, and after the meat was taken out, it ſmelled rank: Raw beef included with a gage, in two days the mercury was riſen an inch; and in ſix weeks the quickſilver was got to the top of the gage; and this meat ſmelled ranker than what had been roaſted: Keeping for 15 days a piece of freſh butter *in Vacuo*, it ſmelt ſtronger than when firſt put in, yet it could ſtill be eaten; whereas another piece of butter was altogether unfit to be uſed.

The Incaleſcence of Mercury *with* Gold. Phil. Tranſ. N° 122. p. 515.

THO' ſeveral objections may be made to the ſympathy of gold with quickſilver, yet there may be a more ſubtle and penetrating mercury than the common, which may ſupply the chymiſt with ſpecious arguments for it. It has been warmly diſputed, whether mercury mixed with gold reduced to fine parts, will produce any ſenſible heat; the affirmative is aſſerted by ſome, who pretend to the tranſmutation of metals; aſcribing this virtue to mercuries extracted, as they ſuppoſe, from ſome perfect metals, and which they call the mercuries of metallic bodies; but the negative is more generally held, not only by philoſophers and phyſicians, but by the more learned chymiſts themſelves, eſpecially the modern: But notwithſtanding all this, the author, for ſeveral reaſons, looking on mercury as a body not ſo homogeneous as is ſuppoſed, was for the opinion of a poſſibility of an incaleſcent mercury; and applied himſelf to diſcover whether a cleanſed and carefully diſtilled mercury might not be a compounded body; and whether out of ſuch a diſtilled mercury, parts plainly heterogeneal might not be ſeparated; and both theſe trials ſucceeded; which was inducemeut enough to try, whether theſe heterogeneal particles might not ſo alter the mercury, as to diſpoſe it to heat with gold: He took to one part of his mercury, ſometimes half the weight, and ſometimes an equal weight of refined gold reduced to calx, or a ſubtle powder; and putting this with the mercury upon it on the palm of his hand, he ſtirred and preſſed them a little with his fingers, by which the two ingredients were eaſily mixed, and became not only ſenſibly but conſiderably hot, and that in ſo ſhort a time as a minute: He found the experiment ſucceed, whether he took an equal quantity, or half as much gold as mercury; but the effect ſeemed to be much greater in the former caſe: He alſo tried the ſame mercury with refined ſilver, reduced to a very fine powder; but could not perceive any heat or warmth at all; tho' he thinks it might have ſucceeded with a ſufficient quantity of leaf-ſilver.

Whereas, it is uſual to take from four to ten parts of common quickſilver, to make an amalgama, with one of gold, even when both are heated by the fire; he found his mercury would preſently incorporate with no leſs than an equal weight, and produce a pretty hard amalgama or mixture, wherein the mercury was ſo diffuſed, that the gold had quite loſt its colour: He adds, that the power of penetrating, and growing hot with gold is ſo inherent in his mercury, that after it had been ſeveral times diſtilled from gold, he found it retain that property: The calx of gold to be uſed in this trial muſt be ſuch as is made by quartation, that is, by melting together one part of fine gold, and three or four parts of coppelled ſilver, and then putting the maſs into purified *Aqua-fortis*; which, diſſolving the ſilver only, leaves the gold in the form of a fine calx; alſo, by making an amalgama with pure gold and common mercury, and diſſolving the mercury in good *Aqua-fortis*, there will remain a powder, which, when well waſhed in fair water, in order to dulcify it, and kept a while in a moderate fire, that it may dry thoroughly without melting, will become a calx, which he uſed with his mercury more than once with good ſucceſs; inſtead of the calx he ſometimes uſed a competent quantity of leaf-gold, and adding two or three times the weight of mercury to it, a ſmart heat was preſently produced.

Pneumatical Experiments on Animals; *by M.* Huygens *and M.* Papin. Phil. Tranſ. N° 122. p. 542.

UPON including *in Vacuo* an inſect reſembling a beetle but ſomewhat larger, when it ſeemed to be dead, the air was re-admitted, and ſoon after it revived; putting it again *in Vacuo*, and leaving it there for an hour, after which the air was re-admitted, it was obſerved that the inſect required a longer time to recover; including it the third time for two days, after which the air was admitted, it was ten hours before it began to ſtir; but putting it a fourth time for eight days, it never afterwards recovered; including a butterfly, on the admiſſion of the air, the upper part of its back, which before was much ſwelled, ſubſided conſiderably, and the animal could not recover: Several birds, mice, rats, rabbets and cats, were killed *in Vacuo*; but if the air were admitted before the engine was quite exhauſted, ſome of them would recover; yet none revived that had been in a perfect *Vacuum*: M. *Guido* made frequent diſſections of animals thus killed, and he obſerved among other things, that their lungs ſunk in water; and he aſcribed the ſolidity or cloſeneſs of the lungs of animals that die *in Vacuo*, to the ſtrong preſſure of the blood, propelled into the lungs by the *Vena Arterioſa*, upon the *Bronchi* of the wind-pipe, whereby the air is expelled out of them, and their ſides made to adhere to each other; but it does not at all appear probable, that the ſmalleſt ramifications of thoſe *Bronchi*, which are hard, can be compreſſed by the *Vena Arterioſa*: It is therefore far more likely, that the lungs, if at all, are compreſſed by the *Pleura*, which may be ſwelled within the breaſt, as the ſkin is ſwelled without.

Promiſcuous Pneumatical Experiments; *by M.* Huygens *and M.* Papin. Phil. Tranſ. N° 122. p. 544.

PUtting a covered receiver, a quarter of which was filled with water over the flame of a candle, the water was obſerved to boil very quick, and yet the glaſs not much heated, ſo that the water boiled near a quarter of an hour, and the glaſs continued only luke-warm; and after it was removed from the flame, it continued boiling a great while; upon repeating the ſame experiment with a gage, the bubbles that iſſued out of the water did not make the mercury riſe ſenſibly:

Afterwards expoſing this receiver to the froſt, the ice formed in it was not quite free of bubbles, notwithſtanding the great diſcharge of them *in Vacuo*; yet they were fewer than the bubbles in ordinary water; the quickſilver was not obſerved to be much raiſed in the gage; afterwards this ice was melted, and the water ſet to freeze again, ſtill without taking it out of the *Vacuum*, and this ſecond time it was freer from bubbles.

After this, ſpirit of wine was made to boil *in Vacuo*, and it boiled much ſooner, and made the mercury riſe about an inch in the gage; after it was taken from the fire, it continued boiling; and even ſinking the receiver into cold water, it boiled more ſtrongly.

Upon putting the weight of 18 grains of powder with a gage into a receiver, that held ſeven pound of water, and firing the powder, it raiſed the mercury an inch and a half; from which it appears that there is $\frac{1}{5}$ of air in gunpowder, upon the ſuppoſition that air is about 1000 times lighter than water; for in this experiment, the mercury roſe to the 18th part of the height at which the air commonly ſuſtains it; and conſequently the weight of 18 grains of powder yielded air enough to fill the 18th part of a receiver that contains ſeven pound of water; now this 18th part contains 49 drams of water; wherefore the air, that takes up an equal ſpace, being 1000 times lighter, weighs $\frac{1}{1000}$ of 49 drachms, which is more than three grains and a half; it follows therefore, that the weight of 18 grains of powder contained more than three and a half of air, which is about $\frac{1}{5}$ of 18 grains: It may alſo be calculated, how many times this air has been compreſſed in the powder; but this calculation is more uncertain than the former, becauſe we know not, whether this air took up more or leſs than $\frac{1}{5}$ part of the ſpace poſſeſſed by the powder; but yet it is certain, that tho' it had even taken up $\frac{3}{4}$ of the whole ſpace of the powder, and that the 14 grains of the other matter had taken up no more than the one remaining fourth part, ſtill this air would have been compreſſed about 300 times; to calculate this, ſuppoſe the ſpace of a cubic foot can only contain 72 pounds of gunpowder, which contain more than 14 pounds of air, by the foregoing calculation, which is the quantity found encloſed in $\frac{3}{4}$ of a cubic foot; now this ſpace does uſually contain but about ſix drachms of air; wherefore, to make it hold 14 pounds of air, which is near 300 times ſix drachms, the air muſt needs be compreſſed near 300 times: There is reaſon to believe, that this compreſſion is much greater, becauſe a cubic foot can contain much more than 72 pounds of powder, and becauſe alſo that $\frac{1}{5}$ of the weight muſt not in appearance poſſeſs above the $\frac{3}{4}$, and all the reſt take up no more than $\frac{1}{4}$ of the ſpace of the powder: And therefore it might be thought, that all the effect of the gunpowder proceeds from the air compreſſed therein, and eſpecially in the ſalt-petre, for it has not been yet obſerved that brimſtone yields any: And poſſibly all other fulminations, ebullitions and fermentations may in time be found nothing more than compreſſed air expanding itſelf.

M. Linus's *Objections to the* Theory *of* Light *and* Colours, *anſwered by Mr.* Newton. Phil. Tranſ. N° 123. p. 551.

M. *Linus* inſiſted that the length of the coloured image was cauſed by a bright cloud, and that the experiment was not made in a clear day; nor the length of the image tranſverſe but parallel to the length of the priſm. In anſwer to which, Mr. *Newton* directs to take any priſm, and hold it ſo that its axis be perpendicular to the ſun's rays, and in this poſition let it be placed as cloſe as poſſible to the hole, thro' which the ſun ſhines into a darkened room, the hole being about the bigneſs of a pea; then turning the priſm ſlowly about its axis, the colours will be obſerved to move on the oppoſite wall, firſt, towards that place, to which the ſun's direct light would paſs, if there were no priſm, and then back again; when the colours are in the middle of theſe two contrary motions, that is, when they are neareſt that place to which the ſun's direct ray tends, there ſtop; for then the rays are equally refracted on both ſides the priſm; in this poſition of the priſm, obſerving the figure of the colours, they ſhall be found oblong and not round, and ſo much the more ſo, as the angle of the priſm comprehended by the refracting planes is greater, and the wall, on which the colours are projected, at a greater diſtance from the priſm; the colours red, yellow, green, blue, purple, ſucceeding in order, not from one ſide of the figure to the other, but from one end to the other; and the length of the figure not parallel but tranſverſe to the axis of the priſm: After this manner Mr. *Newton* uſed to try the experiment; and it will not ſucceed well if the day be not clear, and the priſm placed cloſe to the hole, or ſo near at leaſt, that all the ſun's light that comes from the hole may paſs thro' the priſm alſo, ſo as to appear in a round form, if intercepted by a paper immediately after paſſing the priſm: In the experiment it is to be obſerved, that the priſm projects from it ſeveral images; the one, the oblong image of colours, which is made by two refractions only; another made by two refractions and an intervening reflexion, which is round and colourleſs, if the angles of the priſm be exactly equal; but if the angles at the reflecting-baſe be not equal, it will be coloured, and that ſo much the more, by how much the more unequal the angles are, loſe and much more of its roundneſs, unleſs the angles be very unequal: There is a third image made by one ſingle reflexion, and this is always round and colourleſs; the only danger is in miſtaking the ſecond for the firſt; but they are diſtinguiſhable not only by the length and lively colours of the firſt, but by its different motions too; for, whilſt the priſm is turned continually the ſame way about its axis, the ſecond and third move ſwiftly, and proceed always in the ſame way, till they diſappear; but the firſt moves ſlowly, and grows continually ſlower, till it be ſtationary, and then it turns back again, and goes back faſter and faſter, till it vaniſh in the place where it began to appear: If without darkening the room, the priſm be held at the window, in the ſun's open light, ſo as its axis be perpendicular to the ſun-beams, and then it be turned about its axis, the firſt image will be ſeen; afterwards doubling up a paper once or twice, and making a round hole in its middle, about $\frac{1}{5}$ or $\frac{3}{4}$ of an inch broad, and holding the paper immediately before the priſm, that the ſun may ſhine on the priſm thro' that hole, and the priſm being held ſteady in that poſture which makes the image ſtationary, if it fall directly on an oppoſite wall, or on a ſheet of paper placed at the wall, ſuppoſe 15 or 20 foot from the priſm, or further off, the image will be ſeen oblong, with the red at one end, the violet at the other, and the blueiſh green in the middle; and if the room be made as dark as poſſible, the colours will be more conſpicuous.

Obſervations in a Voyage *from* Venice *to* Smyrna; *by Mr.* Fr. Vernon. Phil. Tranſ. N° 124. p. 575.

AT *Pola* in *Iſtria*, an ancient republic, there ſtill remains an amphitheatre entire; it is of two orders of *Tuſcan* columns placed over each other, and the lower pillars ſtand on pedeſtals, which is uncommon, for ordinarily they have nothing but their baſes to ſupport them; there are beſides a temple dedicated to *Rome* and *Auguſtus*, a triumphal arch, built by a lady of the family of the *Sergii*, in honour of ſome of her kindred, who commanded in thoſe parts; and there are in divers parts of the town ſeveral inſcriptions and ancient monuments: *Zahara*, anciently called *Jadera*, is now the metropolis of *Dalmatia*, and is very well fortified, having the ſea on three ſides, and towards the land it has a caſtle and a rampart of very lofty baſtions; and here are ſeveral ancient inſcriptions: At *Spalatro* in *Dalmatia* is *Diocleſian*'s palace, a vaſt and ſtupendious fabric, where he lived after his retreat from empire; it is as big as the whole town, which is built from its ruins, and ſaid by ſome to take its name from it; the building is maſſive; within it is an entire temple of *Jupiter* of eight ſides, with noble porphyry pillars and admirable corniches; before it is a court adorned with *Egyptian* columns of the ſtone called *Pyropoicilos*, and under it a temple now dedicated to St. *Lucia*; here and there in the town are ſeveral fragments of antiquity with inſcriptions and other things worth obſerving: Four miles from *Spalatro* lies *Salona*, which ſhews the ruins of a great town; about as much farther from *Salona* ſtands *Cliſſa* upon a rocky hill, a frontier fortreſs of the *Venetians* againſt the *Turks*: At *Leſſina* there is nothing remarkable, only that *Biondi*, who wrote our *Engliſh* hiſtory, was a native of it; *Trau* is ancient, and diſcovers good ſigns of being ſo, here Mr. *Vernon* converſed with Dr. *Staſileo*, who publiſhed the fragment of *Petronius Arbiter*, the manuſcript of which himſelf had ſeen: Paſſing the gulf of *Budua*, he ſaw the mountains of *Antivari*, the plain of *Durazzo* and *Apollonia*; and from *Saſſino* a ſmall iſland, could be ſeen the town of *Valona*, and the mountains *Acroceraunii*, now called the mountains of *Chimera*.

Mr. *Vernon* ſtaid a fortnight at *Corfu*, and he had time to view the gardens of *Alcinous*, or the place where they are ſuppoſed to have been, now called *Chryſida*, a moſt delicious ſituation; as alſo the ancient port, now called *Necrothalaſſa*, and ſeveral foundations of ancient fabrics: In *Zante* he obſerved but few antiquities; what is modern is very flouriſhing, and the iſland is rich and plentiful; from *Zante* he went to *Patras* in *Achaia*, a town of good note among the ancients; near it is a large mountain, mentioned by *Homer* under the name of *Petra Olenia*: In the town are ſeveral maſſive ruins, and among the reſt the remains of a large temple dedicated to St. *Andrea*, who, they ſay, was martyred there; the plain about the town is fruitful, abounding in ſprings and rivulets, with fine groves of olive, cypreſs, orange and lemon-trees; the citrons here are reckoned the beſt in the *Turkiſh* empire, and ſent as preſents to *Conſtantinople*; and all their fruits are in good eſteem: At *Athens* Mr. *Vernon* ſpent two months; next to *Rome* he thinks it the moſt worthy to be ſeen for antiquities; the temple of *Minerva* is as entire as the *Rotonda*; the length of the *Cella*, or body of the temple without-ſide, is 168 *Engliſh* feet, the breadth 71, and theſe meaſures are exact to half a foot; the portico of the *Doric* order, which runs round it, hath eight pillars in front, and ſeventeen on the ſides; the length of the portico is 230 *Engliſh* feet, the fuſte or ſhaft of the pillars is 19 ½ feet in circumference; the intercolumniation, or ſpace between the columns, is 1 ¼ of the diameter of the pillars: The temple of *Theſeus* is likewiſe entire, but much leſs, though built after the ſame model; the length of its *Cella* is but 73 feet, the breadth 26; the whole length of the portico, which goes round it, is 123 feet; it is a *Doric* building, as is that of *Minerva*; and both are of white marble: About the corniche, on the outſide of the temple of *Minerva*, is a baſſo relievo of men on horſeback, others in chariots, and a whole proceſſion of people going to a ſacrifice, of very curious ſculpture; on the front, is the hiſtory of the birth of *Minerva*: On the front within-ſide the portico of the temple of *Theſeus*, at the weſt end, is the battle of the *Centaurs*; and at the eaſt end, there ſeems to be a continuation of that hiſtory; and there are ſeveral figures of women, which ſeem to be *Pirithous*'s bride, and thoſe other ladies that were at the wedding; on the outſide the portico, in the ſpaces between the triglyphs, are repreſented ſeveral feats of *Theſeus*, eſpecially in wreſtling, in which he excelled; all his poſtures and looks are expreſſed with great art; again, he is repreſented as encountring monſters, ſuch as the bull of *Marathon*, the bear of *Calydon*, *&c.* There is a temple of *Hercules*, a round ſtructure, only ſix feet in diameter, but of neat architecture; the columns are of the *Corinthian* order, ſupporting an architrave and freeze, whereon are done in relievo, the labours of *Hercules*; the top is but one ſtone, wrought like a ſhield, with a flower on the out-ſide, which riſes like a plume of feathers: The tower of *Andronicus Cirrheſtes* is ſtill ſtanding, an octagon with the figures of eight winds, which are large, and of good workmanſhip; and the names of the winds remain legible in fair *Greek* characters, where a houſe, which is built againſt it on one ſide, does not hinder, as *Apeliotes*, *Euros*, *Boreas*, *Sciron*, *Zephyros*, each wind pointing to its quarter in the heavens; the roof is made of little planks of marble, broad at bottom, and meeting all in a point at top, making an obtuſe pyramid of about 32 or 36 ſides; in the caſtle is a delicate temple of the *Ionic* order, the work is fine, and all the ornaments accurately engraven; its length is 67 feet, its breadth 38: The pillars remaining of a portico of *Adrian*'s, are very ſtately and noble, and of the *Corinthian* order, and above 52 feet high, and 19 ½ in circumference, and channelled; 17 of which are ſtill ſtanding with part of their corniche; the area of the building to which they belong, as near as can be conjectured, was thought to be 1000 feet in length, and about 680 in breadth: Without the town, is a bridge over the *Eliſſus*, of 3 arches of ſolid ſtonework; the middlemoſt is near 20 feet broad; there is ſtill to be ſeen the *Stadium*, whoſe length Mr. *Vernon* meaſured, and found it 630 feet, near to what the preciſe meaſure of a *Stadium* ought to be, *viz.* 625: Towards the ſouth wall of the caſtle, are the remains of the theatre of *Bacchus*, with the portico of *Eumenes*, which is near it; the ſemidiameter is about 150 feet; the whole body of the ſtage 256. *Thebes* is a large town, but few antiquities are found in it, excepting ſome inſcriptions and fragments of the old wall, and one gate, which, they ſay, was left by *Alexander*, when he demoliſhed the reſt; it is about 50 miles diſtant from *Athens*; *Corinth* is two days journey; the caſtle or *Acrocorinthus* is ſtanding, and very large; the moſt part of the town is demoliſhed, and the remaining houſes are ſcattered, and at a great diſtance from each other; as is alſo *Argos*, whoſe compaſs, as the houſes now ſtand, is about 4 or 5 miles; but if they ſtood together, they would ſcarce exceed an ordinary village: *Napola de la Rumilia* is a large town, and populous, and here the baſha of the *Morea* reſides; it is but a few leagues diſtant from *Argos*: *Sparta* is quite forſaken; and *Meſtra*, 4 miles from it, is the town that is inhabited; large ruins are ſeen thereabouts; almoſt all the walls, ſeveral towers, and foundations of temples, with columns and their chapiters are demoliſhed; there is a theatre pretty entire; the town might anciently have been 5 miles in compaſs, and about a quarter of a mile from the river *Eurotus*; the plain of *Sparta* and *Laconia* is very fruitful, and well watered; it ſeems to be 80 miles long; the mountains to the weſt of it are very high, inhabited by the *Maniotes*; but the plain of *Calamatta*, anciently that of *Meſſene*, ſeems to be richer: *Corone* abounds much in olives; *Navarrino*, thought to be the ancient *Pylos*, hath a ſtrong caſtle fortified by the *Turks*, and it is the beſt port in all the *Morea*: *Alpheus* is by much, the fineſt and deepeſt river, and juſtly extolled by the ancient poets, and choſen for the ſcene of the olympic games; the plains of *Elis* are very agreeable and large, fit to breath horſes in, as alſo for hunting; but not ſo fruitful as thoſe of *Argos* and *Meſſene*, which are both richer; the beſt woods in *Peloponeſus* are thoſe of *Achaia*, abounding in pines, wild pear, the *Ilex* and *Eſculus* trees, and where water runs, with plane-trees: *Arcadia* is a pleaſant champaign, and full of cattle, encompaſſed with rugged hills; *Lepanto* is very agreeably ſituated on the gulph, which runs up as far as *Corinth*;

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Corinth; and without the town is one of the fineſt fountains in *Greece*, very rich in water, and ſhaded with large plane-trees, not inferior to the ſpring of *Caſtalia* on mount *Parnaſſus*, which runs thro' *Delphi*; except in this, that the one was choſen by the *Muſes*, and the other not, and that poets have given immortality to the latter, and never mentioned the former: *Delphi* is very oddly ſituated on a rugged hill, to which is an aſcent of about 2 or 3 leagues, which notwithſtanding is not the quarter of the way to the pike of *Parnaſſus*, on the ſide of which hill it ſtands; it ſeems very barren to the eye, but what fruit is there, is very good; the wines are excellent, and the plants and ſimples found there are very fragrant, and of great efficacy: About *Lebadia*, and all over *Bœotia* the plains are very fertile, and make amends for the barrenneſs of the ſurrounding hills; but in winter they are apt to be overflown, and turned into lakes; which renders the *Bœotian* air very thick; theſe vales are much planted with cotton, ſeſamum, and cummin, of which they carry on a great trade with conſiderable profit at *Thebes* and *Lebadia*.

From *Thebes*, Mr. *Vernon* went into the iſland of *Euboea*, or *Negropont*, and ſaw the *Euripus*, which ebbs and flows much in the manner of our tides; only the moon, and ſometimes winds make it irregular; the channel that runs between the town and a caſtle, which ſtands in an iſland over-againſt it, is about 50 feet broad, and there are three mills on it, which ſhew all the changes and varieties that happen in the current; near the *Euripus*, and oppoſite to the town, a port is ſhewn, ſaid to be the ancient *Aulis*, which is not improbable, for it muſt be thereabouts; between *Negropont* and *Athens* is a high hill, called *Agiomacuri*, formerly very dangerous, but now guarded by *Albaneſes*, it is a part of mount *Parnaſſus*; and near it on the left lies mount *Pentelicus*, from whence the *Athenians* anciently fetched their ſtone; where is now a convent of *Calloiers*, the richeſt in all *Greece*: The *Porto pyreo* at *Athens* lies behind *Munichia* at a mile's diſtance, and is ſo large, as to contain 500 veſſels; the ruins of the town are ſtill remaining, and of the walls that joined it to the city of *Athens*; *Porto phalero*, the ancient haven of *Athens*, is rather a road than a port.

Of Shining Fleſh; *by Dr.* Beale. Phil. Tranſ. N° 125. p. 599.

AT *Yeovil* in *Somerſetſhire*, a neck of veal, which ſeemed to be well-coloured, and in good condition in every reſpect, was hung to a ſhelf in a ſmall chamber; next day in the evening, the veal ſhone ſo bright, that the woman of the houſe was ſurprized at it; and her husband obſerving the light, haſtened to it, as fearing fire, and ſeeing it come from the fleſh, he laid hold on it in his left hand, and ſtruck it with his right, as if he would extinguiſh the flames, but without effect; the fleſh ſhone as much, if not more than before; and the hand with which he ſtruck the fleſh, appeared all in a flame, as bright and vivid as the fleſh of the veal; and tho' he thruſt his blazing hand into a pail of water, the flame was not extinguiſhed, but his hand ſhone thro' the water, till at laſt he wiped off all the light with a cloth; the third day the veal was dreſſed, and it eat very well.

After boiling the chitterlings and feet of a porker, and when cold, putting them into ſouſe-liquor or pickle, in a low room to the north, which had little light at noon, and was very dark as ſoon as night began to come on; in four days, thoſe parts of the guts and of the feet, that floated on the top of the pickle, began to ſhine, which ſtill encreaſed every day more and more, but the parts immerſed in water gave no light; in five days more, the light ſeemed as bright as the brighteſt moon-ſhine; thus it continued to ſhine almoſt a week longer, but ſtill fainter and fainter, and in fewer parts; for being often ſtirred, the whole, by degrees, ſunk into the pickle, and then all the light died: Whilſt the light was vivid, by rubbing the hands on the ſhining parts, they alſo communicated a ſtrong light to them; and ſuſpecting this luminouſneſs might be owing to the pickle, the pork was perfectly dried with a napkin, yet the flame was rather encreaſed than diminiſhed; theſe luminous parts ſeemed to emit no warmth: It was obſervable, that by this acquired blaze, the face and hands would appear a great deal larger than the life: The pickle, in which the pork was put, was only made of pure water, bran, and bay-ſalt, and was ſo far from ſhining, that it gradually quenched the light of the ſhining fleſh; whereas the mackrel-pickle, mentioned in N° 13. p. 226, and which was boiled with a mixture of ſweet herbs, by a little ſtirring became ſo luminous, that a drop of it on the palm appeared, as broad as a ſhilling, or rather broader; but it is to be noted, that the mackrel pickle was thick, and not tranſparent, till it was ſtirred and flaming; the pork pickle was clear, yet it ſhined not in any part: Shining worms are ſeldom found in oyſters, as was formerly obſerved by M. *Auzout*, N° 12. p. 203.

The Spiral Structure of the Fibres *of the* Inteſtines: *by Dr.* Will. Cole. Phil. Tranſ. N° 125. p. 603.

THE mechanical reaſon of the periſtaltic motion of the inteſtines, is by ſome anatomiſts deduced principally from annular fibres, conſtituting, according to the received doctrine one of their coats; others are of opinion, that they are rather innumerable, tho' ſmall ſphincter muſcles than ſingle fibres, to which that motion is to be aſcribed; muſcles being in moſt, if not all other inſtances, owned to be the adequate inſtruments of motion, analagous to this; but it is very difficult to conceive, how the actuating matter could be tranſmitted from one fibre or muſcle to another, along the whole tract of the inteſtines, ſince, according to this annular ſuppoſition, each ſingle fibre or muſcle muſt be diſtinct; this and ſeveral other difficulties put Dr. *Cole* upon a ſtricter examination; and to effect a due ſeparation of the membranes and fibres, he cauſed the inteſtines of oxen to boil for five or ſix hours, and thoſe of ſheep for four hours, that their parts might be more eaſily looſened; and he found, that he could not ſeparate a ſingle fibre from its fellows to any conſiderable length, all of them being very ſmall, and running ſmaller and ſmaller in ſeparating, and eaſily breaking on account of their implication and ſtrict coheſion with each other, but a number of them would riſe together: That when he begun at the top, and attempted the ſeparation of one of theſe ſuppoſed annular cluſters of fibres towards the right hand, a whole ring would come off together; but attempting it towards the left, he generally found he could eaſily enough unravel that cluſter to a conſiderable length: When, upon inverting or turning the inſide of the inteſtine outwards, and taking off the glandulous and vaſcular coats, he attempted to unravel the fibres, he found they would come off in the contrary order, *viz.* from the left towards the right; for the inteſtines being inverted, the order of ſeparation muſt be ſo too; and thus he thinks, that this coat is one concave ſpiral muſcle, whoſe upper tendon is fixed in the *Pylorus*, if not higher in the *Sphincter Gulæ*, and the other in the *Anus:* And he propoſes it to be examined, whether the ſuppoſed annular fibres of the veins and arteries may not have the ſame ſtructure as thoſe of the inteſtines; ſince both theſe kinds of veſſels ſeem to have a periſtaltic contraction, and not to be bare pipes to tranſmit the impelled blood.

An Account of Virginia; *by Mr.* Tho. Glover. Phil. Tranſ. N° 126. p. 623.

VIrginia, a part of the continent of *America*, is diſtant from the *Lizard* or *Land's-end* of *England* 1000 leagues, bounded on the eaſt by the ocean, on the weſt by the *Appal-lean* mountains, on the north by *De la Ware*'s bay and river, and on the ſouth by the river *Roanoak*; it lies within a bay called the bay of *Cheſapeek*, whoſe mouth or entrance is due weſt, and about ſix leagues in breadth, and runs up into the country north and by eaſt about 100 leagues, continuing of the abovementioned breadth a great part of the way, but becomes narrow by degrees, towards the upper end about one half; the water in the channel is generally nine fathom, but in ſome places not above ſeven; the ſouthermoſt cape of this bay lies in 37 degrees N. Lat. and within the ſame are ſeveral little iſlands, on ſome of which there are plantations: There are ſo many large, pleaſant and commodious rivers, that diſcharge themſelves into this bay, as is to be ſeen no where elſe; the moſt remarkable are, *James*'s river, *York*, *Rapahannock*, *Potomack*, *Potuxen* and *Choptanck*; the four laſt retain their *Indian* names: Three large rivers empty themſelves at the head of the bay; one whereof is called *Sus-cahannah*, from an *Indian* nation bordering on it: *Potomack*, the largeſt, is 10 miles broad at the mouth, and continues of that breadth for 20 miles up; from which place it is ſix miles broad, and continues ſo for 30 miles higher, its whole length is about 200 miles; this river lies about the middle of the bay; the other rivers are generally two leagues broad at the mouth; and ſome of them 150, others 120 miles in length: The tides are ſcarce diſcernable, when the winds hold at north-weſt; but at other times they flow as they do in *England*, only they appear not ſo large; which may be owing to the tide diffuſing itſelf into ſo many ſpacious rivers: The rivers abound in great variety of delicate fiſh; one ſpecies of which is by the *Engliſh* called a *Sheep's-head*, from the reſemblance of its eye to that of a ſheep; it is generally about 15 or 16 inches long, and half a foot broad; it is a wholeſome agreeable fiſh, and eaſily digeſted; there is another ſort called a *Drum*, many of which are two and a half or three foot long; this is likewiſe a very good fiſh, and very plentiful; there is a jelly in the head of this fiſh, which, taken out and dried in the ſun, then beaten to powder and given in broth, procures ſpeedy delivery to women in labour: At the heads of the rivers are ſturgeon, and in the creeks great plenty of ſmall fiſh, as pearch, crokers, taylors, eels and ſeveral others whoſe names are unknown; oyſters are here ſo plentiful that ſhip-ladings may be had of them; at the mouth of *Elizabeth* river they appear on rocks a foot above water; there are alſo in ſome places great ſtore of muſcles and cockles; there is alſo a fiſh called a ſting-ray, reſembling much a ſkate, only on one ſide of his tail grows out a ſharp bone, like a bodkin, about four or five inches long, with which he ſtrikes and wounds other fiſh, and then preys upon them: In the river *Rapahannock*, Mr. *Glover* ſaw an odd ſort of creature, very much reſembling a man, only ſomewhat larger, ſtanding upright in the water, with his head, neck, ſhoulders, breaſt and waſte above water; his ſkin was tawny, much like that of an *Indian*; the figure of his head was pyramidal, and ſlick without hair; his eyes large and black, as were alſo his eye-brows; his mouth very wide, with a broad black ſtreak on the upper lip, turned upwards at each end like muſtachoes; his countenance was grim and terrible; his neck, ſhoulders, arms, breaſt and waſte were like thoſe of a man; his hands, if he had any, were under water; he ſeemed to ſtand with his eyes fixt for ſome time on Mr. *Glover*, and then he plunged, and in a little after roſe again at a ſomewhat farther diſtance, and turned his head towards him again, and then he ſunk a little under water, and ſwam ſo near the ſurface, that he could obſerve him throw out his arms and gather them in as a man does; at laſt he plunged his head downwards, by which means his tail appeared above the water, which exactly reſembled that of a fiſh, with a broad fin at the end of it: On the bay and rivers there feed ſo many wild-fowl, as in winter to cover the water for two miles; the chief of which are wild ſwans, geeſe, cormorants, brants, ſhield-fowl, duck, mallard, teal, wigeons and many others: The rivers likewiſe abound in beavers and otters; the teeth of the former are ſo ſtrong and ſharp, that they gnaw down trees, wherewith they make dams croſs the waters, under which they keep, uſually called beaver-dams, and in ſome places ſerve for foot-bridges: The original ſprings of all theſe rivers ariſe at the foot of the *Appal-lean* mountains; but the cataracts or falls of theſe rivers are 60 or 70 miles diſtant from the mountains; theſe mountains have their beginning northward at the lake of *Canada*, and run all along the back of the country to the ſouth-weſt as far as the lake *Uſberre*, which is ſome hundreds of leagues: The ſhores all along the bay and rivers are generally ſandy, only in ſome points there is ſome ſhingle caſt up; the earth affords very few ſtones, and ſuch as are found are hard and tranſparent, and ſeveral of them cut glaſs as well as any diamond, and ſome *Virginia*-ſtones equal diamonds in luſtre; the cliffs in all the rivers are full of great veins of iron-ore, and in ſome parts of the country rocks of it are ſeen lying a foot above the earth; and generally the high country under the mould is a mere rock of iron-ore.

They diſtinguiſh their ſoil in three ſorts, *viz.* high, low, and marſhy land; all which are mixed with ſome ſand, which makes their ſoil warmer than the *Engliſh*; their high lands are moſtly ſandy, yet they bear good crops of tobacco; only it does not hold its ſtrength ſo long as the low ground, which is very rich, being a blackiſh mould, about a foot deep, or ſomewhat more, and will hold its ſtrength for ſeven or eight crops ſucceſſively without manuring: Their marſh lands bear ſedges and ruſhes; their land in general is as good and fertile as that of *England*; when the ſtrength of their ground is exhauſted, they never manure it to bring it in heart, but let it lie for paſture.

There are ſeveral ſorts of timber in this country; four ſeveral ſorts of oak very tall and ſmooth; there is alſo another ſort of timber called hickery, which is harder than oak; there are alſo very large tall poplars; and in ſome parts of the country great ſtore of pines fit for maſts; there is alſo black walnut, cypreſs, cedar, dogwood, aſh, elm, gum-tree, locuſt, cheſnut, hazel, ſaſſafras, holly, elder, *&c.* their fruit trees are very numerous, ſo that there are few planters without their orchards, ſome containing 1200 trees and upwards, bearing all ſorts of *Engliſh* apples, as pearmains, pippins, ruſſetins, coſtards, marigolds, king's apples, magitens, batchelors, *&c.* of which they make a great deal of cyder; they have alſo great peach-orchards, which bear ſuch infinite quantities of peaches, that at ſome plantations they beat down to the hogs forty buſhels in a year; quinces are alſo very numerous, and larger and fairer than the *Engliſh*, and not ſo harſh in taſte; of the juice of theſe they alſo make quince-drink; they have alſo apricocks, and ſome ſort of *Engliſh* plums, but theſe do not ripen ſo kindly as they do in *England*; there are here ſome ſorts of pears, but in very few plantations, as *Burgundy*, *Warden*, and two or three other ſorts, and theſe as fair, large and pleaſant as in *England*; here figs grow as good as in *Spain*; it is obſerved that neither oranges nor lemons will grow here, tho' they thrive in more northerly countries; cherries are as plentiful all over *Virginia* as they are in *Kent*; and the cherry-trees grow generally larger than in *England*, and bear more plentifully without digging about them, or pruning; in ſome places of the woods there grows wild a plum ſomewhat like our white plum, but exceeding it, being much more juicy and ſucculent; the woods abound in vines, which twine about the oaks and poplar, and run up to their tops; theſe bear a kind of red grapes, whoſe wine is ſmaller than *French* claret; and Mr. *Glover* is of opinion, that if ſome of theſe vines were planted in convenient vineyards, where the ſun might have a more kindly influence upon them, and carefully kept and pruned, they might afford as good grapes as the claret grapes of *France*; there is alſo in the woods a little ſhrub with a berry like that of our elder, which is very pleaſant to eat; there is a tree called a chincopine, which bears a nut reſembling a cheſnut, and with a rough huſk, but much ſmaller; their gardens yield all ſorts of pot-herbs and ſallads, as cabbages, coleworts, colly-flowers, parſnips, carrots, potatoes and yams; they have alſo in their gardens, roſes, clove-gilly-flowers, and variety of other ſorts of flowers; all ſorts of plantane, yellow-dock, burdock, ſolomon's-ſeal, agrimony, centaury, ſcabious, ground-ſel, dwarf-elder, yarrow, purſlane and white maiden hair grow wild in the woods; on the ſides of the hills, *Aſarum*; and on the bay-ſide, *Soldanella*, or ſea ſcurvy-graſs in great plenty; there is alſo an herb called dittany by ſome, and pepper-wort by others, growing a foot or a foot and a half high, the leaves are about the breadth of a groat, and ſhaped like a heart, which ſhoot out of the ſtalk and branches one of a ſide, directly oppoſite to each other; it ſmells hot like pepper and bites the tongue; the diſtilled water of this herb is one of the beſt remedies againſt worms; an ounce of this water provokes ſweat plentifully: Here grow two roots thought by ſome phyſicians to be *Turbith* and *Mechoacon*; they are both ſtrong purgatives; there grows a plant about a foot and a half or two foot high, the leaves are rugged like thoſe of borage, but longer, and about two fingers broad about the ſtalk where the leaves grow, the berries when ripe are yellow; the *Engliſh* call it the fever or ague-root; when this root is newly taken out of the ground, and a drachm and a half of it infuſed in beer and water for 12 hours, it purges downwards with great violence; but a drachm of the root in powder provokes ſweat only, and that but moderately; it is a little bitter in taſte, and therefore ſomewhat hot: In winter they feed their cattle only with huſks of *Indian* corn; their horſes are as numerous and good as thoſe in *England*; they keep but few ſheep, becauſe of the wolves which infeſt the country; the woods abound in deer, and they have ſome rabbets, which are generally miſtaken for hares; there are alſo ſeveral ſorts of ravenous beaſts, as wolves, racoons, wild cats, poſſums, monacs, flying ſquirrels, and in the more northerly parts of the country ſome bears; the fowl that keep the woods are wild-turky, turky-buzzards, turtle-doves, partridges, hawks of ſeveral ſorts, with many others of leſs note; there are alſo divers kinds of ſmall birds; of which the mocking-bird, the red-bird, and humming-bird are the moſt remarkable; the firſt for variety and ſweetneſs of notes, the ſecond for his colour, and the laſt for the ſmallneſs of his body; as to the mocking-bird, beſides his own natural notes, which are many and agreeable, he imitates all the birds in the woods, whence it takes its name; it ſings not only by day, but alſo at all hours of the night on the tops of chimneys; its poſtures in flying are very odd, ſometimes with his tail bolt upright, and his head down, and on the contrary; when kept tame, it is very teachable: The red-bird takes its name from its colour, being all over of a pure blood-red: The humming-bird is ſo called from the noiſe it makes in flying; it is of ſeveral colours, and not much bigger than an hornet, and yet it hath all the parts of a bird entire: There are five or ſix ſorts of ſnakes, of which the rattle-ſnake is the moſt remarkable, being about the bigneſs of a man's leg, and generally about a yard and a half in length; it hath a rattle at the end of its tail, with which it makes a noiſe upon the approach of any perſon to it, which ſeems to be a peculiar providence of God for people to avoid the danger; for this creature is ſo venomous, that its bite is of very dangerous conſequence, unleſs a proper antidote be ſpeedily applied; there are alſo long black ſnakes, and ſhort thick black ſnakes; theſe latter ſometimes ſuck cows, and make them give bloody milk: There is another ſort called the corn-ſnake, becauſe uſually found in corn-fields, which is near as big as the rattle-ſnake; there are alſo many water-ſnakes that keep the ſprings and rivers.

The *Indians* are generally well proportioned as to ſtature, being ſomewhat tall, but no ways corpulent; their hair is black, uſually hanging ſtraight down; their eyes are alſo black, and their ſkin tawny, inclining to a blackiſh colour; they live together in towns, and every town is under a ſeveral king: At the firſt coming of the *Engliſh*, every town had 2 or 3000 bow-men: For cloaths, they wear a deer's-ſkin tucked about their middle, and

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and another about their ſhoulders; and for ſhoes, they uſe pieces of deer's ſkin tied about their feet: They live in cabbins, about nine or ten foot high, which are made in this manner; they fix ſix poles in the ground, and approaching their tops, they faſten them together; the outſide of the poles are lined with bark, to defend them from the injuries of the weather, leaving a hole a-top for the ſmoak; round the inſide of their cabbins they throw up banks of earth, which ſerve inſtead of ſtools and beds; all their houſhold furniture conſiſts in earthen pots, wooden bowls, and thin mats to lie on, which are all of their own manufacture: Their fare is *Indian* corn, veniſon, wild turkies, oyſters, freſh water-fiſh, and all the wild beaſts of the woods: They are prohibited the keeping either cows, ſheep, or hogs, by the *Engliſh*, leaſt they ſhould make bold with more than their own: Their manner of catching fiſh is this; at the head of their canoes they fix a hearth, on which, in a dark night they make a blaze of pine-tree, and paddle their canoes along the ſhore in ſhallow water; the fiſh ſeeing the light, come as thick as they can ſwim about the heads of the canoes; then, with ſharp-pointed ſticks, they prick them, and take them up into the canoe: Their prieſts are generally thought to be conjurers; for when they want rain, one of theſe prieſts goes into a private cabbin, and by his invocations, he cauſes a plentiful fall thereof, which they call *making of Rain*: They offer the firſt fruits of every thing they have: They burn the bodies of the dead, and ſew up the aſhes in mats, and place them near the cabbins of their relations: Some of them ſay, that the God of the *Engliſh* is a good God; but their own an angry God, who often beats them: Every town almoſt differs in language, and yet none of them is copious; as may be ſeen by their frequently expreſſing their minds to each other by ſigns: Their money is of two ſorts; one made of a white kind of ſhell, which they divide into ſmall parts, and put on a ſtring in the manner of beads; this they call *Peacke*; the other ſort is a blue ſhell ordered in the ſame manner, and which they call *Rounda*; this laſt is the baſer ſort, of which half a yard is equal to our nine-pence; the principal *Indians* wear ſome of this ſort on their deer's ſkin, laid on like lace: All their commodities conſiſt in deer's ſkin and ſome beaver, which they exchange with the *Engliſh* for guns, gun-powder, ſhot, and brandy: They reckon their time only by the changes of the moon: Their winter is uſually in *November*, *December*, and *January*: They are very revengeful, for if any one of them happen to be ſlain, ſome of his relations will kill the murderer or ſome of his family, tho' for two or three generations after: Their uſual way of cure in moſt inward diſtempers is by decoctions, which they make partly pectoral, partly ſudorific, and which they adminiſter twice or thrice a day, in the quantity of half a pint at a time; but they give nothing to procure vomiting in any diſtemper, looking on it as a bad omen that the diſeaſed will die; they are obſerved to uſe neither bleeding nor cupping: Every *Indian* carries a powder about him to cure the bite of ſnakes, and almoſt in every town this powder is differently compounded: The *Indians* are frequently ſubject to violent cholics, which afterwards terminate in palſies.

Their manner of planting and ordering tobacco is this, in the twelve days they begin to ſow their ſeed in beds of fine mould, and when the plants are grown to the breadth of a ſhilling, they are fit to tranſplant to the hills; for in their plantations they make ſmall hills, at about the diſtance of four feet from each other, ſomewhat in the manner of hop-yards; theſe hills being prepared againſt the time the plants are grown to the abovementioned bigneſs, which is about the beginning of *May*; they then in moiſt weather draw the plants out of their beds, and replant them in the hills, which they afterwards carefully weed; when the plant hath put forth ſo many leaves as the ground will nouriſh to a ſubſtance and largeneſs as will make them ſaleable, they then take off the top of the plant; if the ground be very rich, they let a plant put forth twelve or ſixteen leaves, before they top it; if poor, then not above nine or ten, and ſo in proportion to the goodneſs of the ſoil; after the top is taken off, the plant grows no higher, but will afterwards ſend forth ſuckers between the leaves, which they pluck away once a week, till the plant come to perfection, which it does in *Auguſt*; then in dry weather, when there is a gentle breeze of wind, they cut down what is ripe, letting it lie about four hours on the ground, till the leaves that ſtood ſtrutting out fall down cloſe to the ſtalk; then they carry it on their ſhoulders to their tobacco-houſes, where a peg is driven into the ſtalk of each plant; and as faſt as they are pegged, they are hung up by the pegs on tobacco-ſticks, ſo near each other, that they juſt touch; thus they let them hang for five or ſix weeks, till ſuch time as the ſtem, in the middle of the leaf, will break in the bending of it; then when the air has ſo moiſtened the leaf, as that it may be handled without breaking, they ſtrike it down, ſtrip it off the ſtalk, bind it up in bundles, and pack it into hogſheads for uſe: Sometimes they are forced to plant their hills twice or thrice over, on

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account of an earth-worm, which eats the root; and when the plant is well grown, they ſuffer damage by a worm, that devours the leaf, called a horn worm, which is bred upon the leaf; if theſe worms be not carefully taken off, they will ſpoil the whole crop: In *Auguſt* 1667, there happened all over *Virginia* a guſt, or ſtorm of wind and rain, which continued for three days with ſuch violence, that the like was hardly ever heard of; it began and continued blowing at eaſt with ſuch fierceneſs, that above one half of the crop of their tobacco, which was then ſtanding in the fields, was blown away and torn to pieces; the trees in the woods, all over the country, were rooted up in great numbers; the waters in the bay were at ſome places driven a great way into the woods; and ſuch as had houſed their tobacco, had their houſes blown down, and their tobacco ſpoiled: The planter's houſes are built all along the banks of the rivers, for the conveniency of ſhipping; they build after the *Engliſh* manner, whitening the inſide of their houſes with mortar, made of burnt oyſter-ſhells inſtead of lime: Their water is pure and wholeſome, and all from ſprings, of which the country is ſo full, that there is ſcarce a houſe without one at the door.

The Quantity of a Degree *of a great Circle in* Engliſh Meaſure; *by Mr.* Norwood. Phil. Tranſ. N° 126. p. 636.

ANNO 1635, Mr. *Norwood* obſerved as exactly as poſſible, at the ſummer ſolſtice, the altitude of the ſun at noon in the middle of the city of *York* with a ſextant of more than 5 foot *Radius*, and found it to be 59° 33′. And having formerly, *viz.* in 1633, obſerved the like altitude near the tower of *London*, he found it to be 52° 1′. Whereupon, he actually meaſured with chains, the greateſt part of the way from *York* to *London*, and where he meaſured not, he paced it; wherein, he ſaid, by cuſtom he came very near the truth; obſerving all the way he came, with a circumferentor, the principal angles of poſition, or windings of the road, with a competent allowance for other ſmaller windings, aſcents, and deſcents; not laying theſe down by a protractor after the uſual manner, but framing a table much more exact and fitter for this purpoſe; and thus he found the diſtance of the parallel of *York* from that of *London* to be 9149 chains, every chain being 6 poles, or 99 feet, reckoning 16 ½ feet *Engliſh* to a pole; now the above 9149 chains being equal to 2° 28′, the difference of latitude between the two cities, by a little calculation it appears, that one degree of a great circle, meaſured on the earth, is 367196 of our feet, or in round numbers 367200, or

22254 poles, which make 556 furlongs, and 14 poles, or 69 ¼ *Engliſh* miles, and 14 poles; reckoning 8 furlongs to a mile, and 40 poles to a furlong; which, compared with M. *Picard*'s meaſure of a degree, will be found to come very near it; for he finding 73 miles nearly, at 5000 feet to an *Engliſh* mile, which make 365000 feet; whereas the 69 ¼ *Engliſh* miles and 14 poles, found by Mr. *Norwood*, amount to 367200 feet, reckoning 5280 feet to an *Engliſh* mile, as the true meaſure of it is; whence the difference between theſe two meaſures appears to be no more than 2200 feet, which is not half an *Engliſh* mile by 440 feet; the circumference of the earth, according to this meaſure is, 25056 miles nearly, and the diameter 7966.

Of the Effects of Thunder *and* Lightening *on* Sea Compaſſes; *Remarks on the gradual Alteration of the Temperature of the* Air *in different Countries*; *of an uncommon* Hygroſcope, *&c.* Phil. Tranſ. N° 127. p. 647.

IN the latitude of *Bermudas*, Mr. *Groſton* of *New England*, was ſurprized with a dreadful ſtorm of thunder and lightning, which affected his compaſs in ſuch a manner, that the ſouth and north points had changed poſitions; and tho' the flower *de Luce* was brought to point directly north, it would immediately, as ſoon as it was at liberty, return to its new direction; and in the ſame manner every compaſs in the ſhip was affected, and theſe thunder-ſtruck compaſſes never recovered, as far as is known, their right directions again.

In *America*, as far, at leaſt, as the *Engliſh* plantations have extended themſelves, there is an extraordinary alteration as to the temperature of the climate, ſince the *Europeans* firſt began to ſettle there; which change is generally aſcribed to the cutting down of vaſt woods, as alſo to the clearing and cultivating of the country; but that *Ireland* ſhould be ſubject to ſuch a change of temperature without any ſuch manifeſt cauſe, doth very much invalidate that reaſon; for, if it be true, as ſome compute, that this kingdom was better inhabited and manured before the late civil wars, than at preſent, *viz.* 1676, it ſhould, according to the reaſons alledged for the change of temperature in *America*, be rather grown more intemperate, *viz.* for want of cultivation; but the contrary is obſervable here, *viz.* that this country becomes every year more and more temperate: And it has not been unuſual here to have froſt and deep ſnows of a fortnight's and three weeks continuance, and that twice or thrice, and ſometimes oftner in a winter; nay, great rivers and lakes to have been frozen all over; whereas of late, eſpecially for theſe two or three years laſt paſt, we have had ſcarce any froſt or ſnow at all; neither can this extraordinary alteration be aſcribed to any fortuitous concourſe of ordinary circumſtances, requiſite to the production of fair weather; becauſe it is manifeſt, that it hath proceeded gradually, every year becoming more temperate than the preceeding: Tho' it be obſerved, that froſty and ſnowy winters make early ſprings, and tho' there had been little of either, in the winter 75, yet there never was obſerved a more forward ſpring in *Ireland*, there having been a great number of ripe cherries in *April:* The wind keeps for the moſt part between the north-weſt and the ſouth, and ſeldom at eaſt, and ſeldomer ſtill at north or north-eaſt.

For a hygroſcope, take two pieces of deal-board, tho' poplar would do better, each about two foot long, and a foot or more in breadth, A B, Plate II. Fig. 1. which, after being well plained and ſhotten, that their edges may meet even together, are to be faſtened at each extremity between two ledges of oak C C, two inches broad; this done, ſuppoſing ¼ of an inch to be the utmoſt diſtance, that theſe two boards would ſhrink aſunder in the drieſt weather; then taking a thin piece of braſs D, two or three inches long, and ¼ broad; and upon one edge towards the extremity, meaſuring ¼ of an inch *d d*, and dividing it into five equal parts, and with a ſmall file making them into ſo many fine teeth; this piece of braſs was placed flat a-croſs the joining of the two boards, and one extremity nailed by means of two holes *b b* to the board A only; the other end was left free, reaching to a ſufficient length over the board B; next there was made a pinion *e*, with as many teeth as the piece of braſs had, on the end of a piece of thick iron wire; this axis F with its pinion *e*, was faſtened in ſuch a manner to the other board B, by means of the ſmall arm E, and fitted to the teeth of the braſs plate, that when the boards ſhrink aſunder, the piece of braſs is alſo drawn, and turns this axis, by means of its pinion, more or leſs; and thus, if ever it happen, that the boards gape but ¼ of an inch aſunder, this axis will have made one entire revolution; wherefore, putting a long index G G on the extremity of this axis, and making a circle round it with the uſual graduations, numbered from any point at pleaſure, the motion of the index backwards and forwards will ſhew the degrees of the dryneſs or moiſtneſs of the air: Now this axis may be made to paſs thro' a round plate of wood or metal to conceal the contrivance, as in a clock or watch: It is to be obſerved, that the boards be faſtened to the ledges only at the outer edges, as at *a a a a*, that they may have the greater liberty of ſwelling and ſhrinking.

Plate II. Fig. 2, repreſents a kind of large flying beetle of a dark ſhining brown, with a huge pair of horns, in proportion to the body, ſhaped and branched exactly like thoſe of a ſtag or hart, from which laſt it is denominated in *Virginia* and *New England* the flying-hart; it flies high and ſwift, and reſts moſt commonly upon branches or trunks of ſtanding trees; where, as ſoon as it alights it begins a ſhrill chirping note, which it raiſes gradually till it make the whole woods reſound, and again gradually ſinks, till it end in a kind of ſilent murmur, as if the little animal had ſung itſelf a-ſleep; then it flies to ſome other place, and begins the ſame tune again: Its horns are of a ſhining hard ſubſtance, and their tips are in the ſame plane with the belly.

The teſticles of an animal called muſk-quaſh do ſmell ſtrong of muſk; and ſome of them keep a long time, till they become hard and black, ſmelling as ſtrongly as at firſt, and nothing inferior to the ſcent of that commonly ſold for muſk in the ſhops.

Of the Texture of Trees; *and of* Animals *in* Wine; *by M.* Leewenhoeck. Phil. Tranſ. N° 127. p. 653.

M. *Leewenhoeck* diſcovered in ſeveral trees two ſorts of veſſels or pores, and he was of opinion, that the larger veſſels conveyed upwards the matter which ſerves for the encreaſe of the tree; and that ſome particles did again deſcend in the ſmaller veſſels to the roots, whereby a circulation was maintained alſo in trees; he likewiſe diſcovered a third ſort of veſſels, iſſuing from the middle of the pith horizontally to the circumference, whereas the other two aſcended directly upwards; ſo that the whole body of wood conſiſts of nothing but ſmall hollow pipes: The pipes, of which the firm wood conſiſts, are in many places as clear as cryſtal; and in other places, they ſeem to conſiſt in part of ſmall globules; the great veſſels are generally furniſhed with ſmall membranes, which cut through, may be ſeen to lie obliquely in the veſſels, and theſe he conceives to be valves; Dr. *Grew* makes alſo mention of pithy valves in his *Anatomy of Plants* p. 71; but he proves by ſeveral arguments, that there are no valves, either in the ſap-veſſels or air-veſſels. Plate II. Fig. 3, A B is one of the great pores or veſſels of an aſh-twig of one year's growth, cut lengthwiſe thro' the middle of the pores; which veſſel conſiſted of tranſparent globules, wherein might be plainly ſeen the ſmall oblique membranes called valves, which mem-

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membranes do not lie with their upper part extended one and the ſame way, but in ſuch a manner that two ſides of them with their upper end reach towards each other, as C C and D D: Fig. 4. A B exhibits ſome of the ſmall veſſels, that make up the firm wood, cut off cloſe to the bark lengthwiſe; of theſe veſſels there lie 8, 10, or 12 together, as at C and D: Fig. 5. A H H D E F G is the eighth part of the wood of an aſh-twig, one year old, cut tranſverſely, conſiſting of large veſſels, differing in bigneſs, and the reſt of the wood is an infinite number of ſmall veſſels or pores; G H are veſſels having their origin from the pith, and terminating in the circumference of the woody part: I I are the very ſmall veſſels that are accounted to be the firm wood; E K F is the pith of the twig conſiſting of veſicles or bladders, that have 6, 7 or 8 ſides, and lie very curiouſly with their ſides towards each other.

M. *Leewenhoeck* obſerved ſeveral times in a delicate *French* wine of a year old ſmall living creatures, ſhaped like eels, as A B Fig. 6. having on their forehead a convexity like a creſcent, both the hinder and fore-parts were as tranſparent as cryſtal.

An Hydraulic Engine. Phil. Tranſ. N° 128. p. 679.

THE effect of this engine is to throw out water to a great diſtance, by the compreſſion of the water forced out thro' a tube, which turning every way, is thereby fitted to direct the jet of water to the places where the fire is to be extinguiſhed; what is peculiar in this engine, is, that the jet of the water is continual and not interrupted, even when the ſucker of the pump ceaſes to force: This engine is a cheſt of copper A, Fig. 7. Plate II. pierced above with many holes B B, holding within it the body of a pump E F M, whoſe ſucker D E, is raiſed and lowered by two levers C O, C O, with each of them two arms ſo as to be wrought by the hands of a man; and each lever is pierced in the middle by a mortiſe *a a*, wherein an iron-nail, which paſſes thro' the handle of the ſucker, turns when the ſucker is raiſed or lowered; near the body of the pump is a copper-veſſel I H K, which communicates with it by the tube G, with another tube K N L, which in N may be turned every way.

To make this engine play, water is poured upon the cheſt, which enters in at the holes in its cover; this water is drawn into the body of the pump at the hole F, when the ſucker is raiſed; and when the ſame is depreſſed, the valve of the hole F ſhuts, and forces the water thro' the hole M into the tube G, whoſe valve H being raiſed, the water enters into the pot, and filling the bottom, it runs thro' the hole K into the tube K N L, in ſuch a manner, that when the water is higher than the tube K N L, and the hole of the tube G is ſhut by the valve H, the air incloſed in the veſſel hath no vent; and it happens, that when you continue to make the water enter into the veſſel by the tube G, which is much thicker than the aperture at the extremity L, at which it is diſcharg'd, it muſt needs be, that the ſurplus of the water that enters into the veſſel, and exceeds that which at the ſame time iſſues thro' the ſmall end of the jet, compreſſes the air in the veſſel, by which means, whilſt the ſucker is raiſed again, that new water may enter into the body of the pumps, the compreſſed air in the veſſel drives the ſurplus of water by its ſpring, in the mean time that a new depreſſion of the ſucker makes more water to enter, and cauſes alſo a new compreſſion of air; and thus the ſtream of the water, that iſſues by the jet, is continual.

A direct and geometrical method of inveſtigating the aphelia, excentricities, and proportions of the orbits of the primary Planets, without ſuppoſing the equality of the angle of Motion at the other Focus of the Planets Ellipſis; *by Mr.* Edm. Halley. Phil. Tranſ. N° 128. p. 683. *Tranſlated from the* Latin.

THE annual motion of the earth in the ecliptic, is the cauſe of an optical inequality in the motions of the other planets, well known to the *Copernican* aſtronomers by the name of the parallax of the orbit; this inequality, which is eaſily diſcovered by obſervations, Mr. *Halley* conſtitutes the ſolid baſis of his ſubſequent method; where beſides obſervations, nothing more is ſuppoſed than that the orbits of the planets be elliptical, that the ſun be in their common focus, and in fine, that their periods be diſcovered in ſuch a manner, as that no ſenſible error can ariſe, at leaſt in two or three revolutions; theſe things being granted, let S be the ſun, Fig. 8. Pl. II. A B C D E, the orbit of the earth; P the planet *Mars*, which is to be preferred on many accounts; and in the firſt place let the true time and place, wherein *Mars* is in oppoſition to the ſun, be obſerved; for then the ſun and the earth are in the ſame right line with *Mars*, or, which always is the caſe when it has latitude, with that point where a perpendicular let fall from

Mars meets the plane of the ecliptic; thus in the ſcheme, S A and P are in a right line; then after 687 days *Mars* returns to the ſame point P, where it was in oppoſition to the ſun in the former obſervation; but ſince the earth does not return to A till after 730½ days, in B it reſpects the ſun in the line S B, and *Mars* in the line B P; and obſerving the longitudes of the ſun and of *Mars*, all the angles of the triangle P B S are given; and ſuppoſing P S 100000 parts the length of the line S B is found in the ſame parts; in the ſame manner after a ſecond period of *Mars*, the earth being in C, the line S C is found, and ſo likewiſe the lines S D, S E, S F; and the differences of the obſerved places of the ſun, are the angles at the ſun A S B, B S C, C S D, D S E; and thus at length we come to this geometrical problem, *viz.* three lines meeting in one of the *Foci* of the ellipſis being given both in length and poſition, it is required to find the length of the tranſverſe diameter together with the diſtance of the *Foci*; the reſolution of which is alſo extended to the other planets, if after knowing the theory of the earth's motion, we inveſtigate, according to the method propoſed by Dr. *Ward* Biſhop of *Sarum*, in his *Aſtronomia Geometrica*, *Lib.* 2. *Part.* 2. *Cap.* 5, three diſtances of any planet from the ſun in their poſitions; but becauſe the Dr. ſuppoſes a planet to move in its orbit in ſuch a manner as in equal times to deſcribe equal angles about the other *Focus*, and upon this builds his calculation; it does not ſeem improper to ſhew how the ſame thing may be done without a ſuppoſition which is inconſiſtent with obſervation.

Let S, Fig. 9 be the ſun; A L B K the orbit of the earth; and let P be the planet, or point in the plane of the ecliptic, where a perpendicular from the planet meets it; let A B be the line of the *Apſes* of the earth's orbit: In the firſt place let the longitude and latitude of the planet in P be obſerved, together with the longitude of the ſun from the earth in K; and after a revolution of the ſame planet, the earth being in L, let again the poſitions of the planet and of the ſun be obſerved as before; now from the obſerved longitudes of the ſun and aphelion of the earth, the angles A S K, A S L are given, and conſequently the ſides S K, and S L; for if the angle of the co-equated anomaly be acute, the proportion is, as the difference of the mean diſtance and of the coſine of the angle multiplied into the eccentricity to the aphelion diſtance, ſo is the parhelion diſtance, to the diſtance of the planet from the ſun in the given anomaly; but if the angle be obtuſe, the firſt term of the proportion is the ſum of the two parts, as their difference was in the firſt the former analogy: Now in the triangle K S L, the ſides K S, L S, and the angle K S L are given; the ſide K L, and the angles S K L, S L K are required: Again in the triangle K L P are given the ſide K L, the angle K P L the difference of the obſerved longitudes of the planet, and P K L the difference of the angles S K L laſt found, and S K P the elongation of the planet from the ſun in the firſt obſervation, and L P is ſought: Then in the triangle L S P, the ſides L S, L P, and the angle P L S the elongation of the planet from the ſun in the ſecond obſervation are given, the ſide S P, and the angle L S P are required; which being found, as S P is to L P, ſo is the tangent of the latitude obſerved from L, to the tangent of the inclination or latitude at the ſun; and as the coſine of the inclination is to the radius, ſo is S P the curtate diſtance, to the planets true diſtance from the ſun; and thus we find the poſition and length ſought: Now it remains to ſhew how from three given diſtances from the ſun, together with the intercepted angles, the mean diſtance may be found with the eccentricity of the ellipſis.

Let S, Fig. 10. be the ſun, and S A, S B, S C three diſtances in due poſition; and drawing A B, B C, let A B be the diſtance of the *Foci* of an hyperbola, and $SA - SB = EH$ the tranſverſe diameter; ſuppoſing which, let the hyperbolic line be deſcribed whoſe internal *Focus* is the point A the extremity of the longer line S A: After the ſame manner let B and C be the *Foci* of the other hyperbola, whoſe diameter $SB - SC = KL$; from which let the hyperbolic line be deſcribed, having its internal *Focus* in the point B; I ſay theſe two hyperbola's thus deſcribed interſect each other in the point F, which is the other *Focus* of the ſought ellipſis; and drawing the line F A, F B, or F C; $SA + FA$, $SB + FB$, or $SC + FC$ will be equal to the tranſverſe diameter, and S F is the diſtance of the *Foci*; which being ſuppoſed, the deſcription of the ellipſis is very eaſy; but ſince the reaſon of this conſtruction is not clear to every one, it will not be improper to illuſtrate it a little; therefore I ſay, that from the known property of the ellipſis, $SB + FB = SA + FA$, and tranſpoſing the members of the equation, $FB - FA = SA - SB$; ſo that tho' F B and F A be unknown, yet their difference is equal to $SA - SB$, that is, E H; and ſince it is the nature of the hyperbola to have any two lines from its *Foci* to any points in its curve conſtantly differing by the quantity of the tranſverſe diameter; it is plain that the point F is ſomewhere in the curve of the hyperbola, whoſe tranſverſe diameter is equal to S A — S B, and the *Foci* A and B: After the ſame manner it may be demonſtrated that the point F is in the hyperbola, whoſe diameter is S B — S C, and *Foci* B and C: Wherefore it is neceſſary, that it be in the interſection of theſe two hyperbola's, which, ſince they interſect each other in one point only, clearly ſhew where the other *Focus* of the ſought ellipſis is.

Now to do the ſame thing analytically, ſuppoſe it done, and let $FB = a$, $SA - SB = FB - FA = b$, $AB = c$, $SB - SC = FC - FB = d$, $BC = f$, and let the ſine of the angle A B C $= S$, and its coſine $= s$: Then as $c : b :: 2a - b : \frac{2ab - bb}{c}$, and $\frac{2ab - bb + cc}{2c} = BD$ by 36. 3. *Eucl.* and as $f : d :: 2a + d : \frac{2ad + dd}{f}$ and $\frac{ff - 2ad - dd}{2f} = BG$ by the ſame propoſition; and to leſſen the trouble of calculation let $\frac{cc - bb}{2c} = g$, and $\frac{b}{c} = h$, in the ſame manner let $\frac{ff - dd}{2f} = k$, and $\frac{d}{f} = l$, then $BD = g + ha$, and $BG = k - la$; and becauſe in every

$$\left.\begin{array}{l}\text{obtuſe angled triangle}\\ \text{acute angled triangle}\end{array}\right\} \text{the ſquare of the baſe is equal to} \left\{\begin{array}{l}\text{the ſum}\\ \text{the difference}\end{array}\right.$$

of the ſquares of the ſides and of double the rectangle of the ſides multiplied into the coſine of the comprehended angle, it will be $gg + 2gha + hhaa + kk - 2kla + llaa + 2gks - 2glsa + 2khsa - 2hlsaa$ equal to the ſquare of D G; but D G is equal to the ſine of the angle D F G or D B G multiplied into a, that is, into F B; for the quadrilateral F B D G is inſcribed in a circle whoſe diameter is F B; therefore $SSaa = gg + 2gha + hhaa + kk - 2kla + llaa + 2gks - 2glsa + 2khsa - 2hlsaa$, which equation is eaſily reſolved, ſince it does not exceed an adfected quadratic, and does always conſiſt of theſe ſquares and rectangles; but the ſigns + and — are to be very cautiouſly uſed to the rectangles, on account of the different nature of the three lines: We have fitted our equation to Fig. 10. but in any other caſe it will not be difficult from what is ſaid above to conſtitute a ſimilar one; and thus it is ſhewn how from three heliocentric places of a planet, and obſerved diſtances from the ſun, its orbit may be deſcribed, which before required five ſuch obſervations.

Exceptions againſt the Theory *of* Light *and* Colours; *by Mr.* Lucas. Phil. Tranſ. N° 128. p. 692.

THE vertical angle of Mr. *Lucas*'s priſm was 60°; the diſtance of the wall whereon the coloured *Spectrum* appeared, from the window, was about 18 foot; the diameter of the hole in the window-ſhutter about half an inch, which upon occaſion he contracted to half the ſaid diameter, but ſtill with equal ſucceſs as to the main of the experiment; the refractions on both ſides the priſm were as near as he could make them equal, and conſequently about 48° 40′, the refractive power of glaſs being computed according to the ratio of the ſines as 2 to 3; the diſtance of the priſm from the hole in the ſhutter was about two inches; the room was darkened to that degree as to equal the darkeſt night, while the hole in the ſhutter was covered: Now as to the iſſue of his trials, he conſtantly found the length of the coloured image, tranſverſe to the axis of the priſm, conſiderably greater than its breadth, as often as the experiment was made in a clear day; but if a bright cloud were near the ſun, he found it ſometimes exactly as M. *Linus* did, *viz.* broader than long, eſpecially while the priſm was placed at a great diſtance from the hole: which experiment will not be queſtioned by Mr. *Newton*, it being ſo agreeable to the received laws of refractions; and according to Mr. *Lucas* the obſervations of theſe two learned perſons, as to this particular, are eaſily reconcileable to each other, and both to truth; Mr. *Newton* contending only for the length of the image, tranſverſe to the axis of the priſm, in a very clear day; whereas M. *Linus* only maintained the exceſs of breadth, parallel to the ſame axis, while the ſun is in a bright cloud; tho' as to what is further delivered by Mr. *Newton*, and oppoſed by M. *Linus*, *viz.* that the length of the coloured image was five times the diameter of its breadth, M. *Lucas* never found the exceſs above thrice the diameter, or at moſt three and a half, while the refractions on both ſides the priſm were equal: So much as to matter of fact.

Now as to Mr. *Newton*'s theory of light and colours, Mr. *Lucas* owns that his elegant ſet of ingenious and natural inferences was to him a ſtrong prejudice in favour of this new doctrine; but ſince ſeveral experiments of refractions remain ſtill untouched, he was of opinion a further ſearch into them would be very proper, in order to a farther diſcovery of the truth of his aſſertion; the experiments he pitched upon were as follow. 1. Having frequently obſerved that the form of objects viewed in the microſcope, or rather of the microſcope itſelf, conſiſts almoſt in an indiviſible point, he concluded that two very ſmall pieces of ſilk, the one ſcarlet, the other of a violet colour placed near each other, would according to Mr. *Newton*'s theory, appear in the microſcope in a very different degree of light, in regard their unequal refrangibility muſt cauſe the ſcarlet ray, or ſpecies, to over-reach the *Retina* placed in the due *Focus* of the violet ones, and conſequently occaſion a ſenſible confuſion in the viſion of the former, one and the ſame point of the ſcarlet object affecting ſeveral nerves in the *Retina*; yet on frequent trials he could not perceive any inequality in this reſpect. 2. The ſecond experiment was made in water; he took a braſs ruler and faſtening to it ſeveral pieces of ſilk, red, yellow, green, blue, and violet, he placed it at the bottom of a ſquare veſſel of water; then he retired from the veſſel ſo far, as not to be able to ſee the aboveſaid ruler and coloured ſilks, otherwiſe than by the help of the refracted ray; now, did Mr. *Newton*'s doctrine hold, he conceived he ſhould not ſee all the abovementioned colours in a ſtraight line with the ruler, in regard the unequal refrangibility of different rays muſt needs diſplace ſome more than others; yet, in effect, upon many trials, he conſtantly found them in a ſtraight line, as the bare ruler had appeared in. 3. To confirm this experiment he made a ſecond refraction, by placing a priſm in ſuch a manner as to receive perpendicularly the refracted ſpecies of the ſilk and ruler; whereby the emergent ſpecies ſuffered a ſecond refraction, but ſtill with equal ſucceſs, as to their appearing in a ſtraight line to the eye placed behind the priſm. 4. To theſe two refractions he farther added a third, by receiving the coloured ſpecies obliquely on the priſm; whereby both incident and emergent ſpecies ſuffered their reſpective refractions; but ſtill with the ſame ſucceſs as formerly, as to the ſtraight line they appeared in: For further confirmation in this experiment, ſome indifferent perſons were called into the room, and demanding whether they ſaw not the ſilks and ruler in a crooked line, they anſwered in the negative. 5. The next experiment was made in uncompounded colours; having projected two coloured images on the wall, ſo as the ſcarlet colour of the one fell in a ſtraight line, parallel to the horizon, with the violet of the other: he then looked on both thro' another priſm, and found them ſtill appear in a ſtraight line parallel to the horizon, as they had formerly done to the naked eye; now according to Mr. *Newton*'s doctrine of different refrangibility in different rays, the violet rays ſhould ſuffer a greater refraction in the priſm at the eye than the ſcarlet ones, and conſequently both colours ſhould not appear in a ſtraight line parallel to the horizon. 6. Mr. *Lucas* having for ſome time ſuſpected, that not only the direct ſun-beams, but alſo other extraneous light might poſſibly influence the coloured *Spectrum*; he faſtened a very white paper-circle, about an inch in diameter, upon his window-ſhutter, and viewing it thro' his priſm, he found a coloured image painted thereby on his *Retina*, anſwerable almoſt in all reſpects to the image of the ſun-beams on the wall, eſpecially when the paper-circle was indifferently well enlightened; this image it is true, appeared in an inverted ſituation, that is, the ſcarlet appearing above, the violet below, tho' but faint; but there was nothing ſurpriſing in this, having obſerved upon diſſecting the eye, that objects are painted on the *Retina* in that inverted manner; having fixed his priſm in a ſteady poſture, he cauſed the paper C Fig. 1. Plate III. to be applied cloſe to the paper-circle *a b d*, whereupon the violet *d* and ſcarlet colour of C vaniſhed into whiteneſs; in the next place he removed the ſaid circle from the ſhutter, and placed it in the open window, ſupported only by the edge *d*; upon which all the former colours changed poſitions in the *Retina*; the ſcarlet now appearing below, the violet above, and the intermediate colours ſcarce diſcernible; and here by the bye, it is very remarkable, that during this obſervation both blue and ſcarlet light were clearly ſeen to be tranſparent; whence it follows, that theſe colours do in great part ariſe from the neighbouring light: Laſtly, he placed the paper-circle a-new, ſo as that the one half *b* was faſtened to the ſhutter, the other ſemicircle *a* being expoſed to the open air; upon which the ſemicircle *a* became bordered with violet above, and ſcarlet below; but the other ſemicircle *b*, quite the reverſe; and hence Mr. *Lucas* makes the following inferences; firſt that not only the light reflected from the paper-circle, but alſo from the ambient air, hath great influence upon the coloured image, eſpecially as to the violet and ſcarlet colours; whence perhaps, it will not hereafter ſeem ſtrange, that the coloured *Spectrum* on the wall is of ſuch a length, but only that the breadth is not greater: Secondly, were there a more luminous body behind the ſun, we ſhould in all likelihood have the colours of the *Spectrum* in a contrary ſituation to what they appear in at preſent; whence, thirdly, it ſeems to follow, that the preſent ſituation and order of colours ariſes not from any intrinſic property of refrangibility, but from contingent and extrinſical circumſtances of neighbouring objects; for according as the body behind the paper circle was more or leſs enlightened than the circle itſelf, all the ſeveral colours changed their ſituation. 8. The next experiment was made in order to Mr. *Newton's* doctrine of primary colours; and having covered the hole in the window-ſhutter with a thin ſlice of ivory, the tranſmitted light appeared yellow; but, upon adding 3, 4, or more ſlices, it became red; whence it ſeems to follow, that yellowneſs of light is no primary colour, but a compound of red, *&c.* 9. The laſt experiment was made in reference to Mr. *Newton's* *Prop.* 12, where from his principles he gives a very plauſible reaſon of a ſurpriſing phænomenon, related by Mr. *Hook*, *viz.* of two liquors, the one blue, the other red, both ſeverally tranſparent, yet, if placed together, they became opake; the reaſon whereof, according to Mr. *Newton*, is, that one liquor tranſmitting red only, the other only blue, no rays could paſs thro' both: In reference then to this, Mr. *Lucas* filled two ſmall glaſſes with flat poliſhed bottoms, the one with *Aqua-fortis*, deeply tinged blue; the other with oil of turpentine coloured red; both to that degree, as to repreſent all objects thro' them either blue or red; then placing the one upon the other, he could diſcern ſeveral bodies thro' both; whereas, according to Mr. *Newton's* theory, no object ſhould appear thro' both liquors; becauſe, if one tranſmit only red, the other only blue, no rays can paſs thro' both.

The preceeding Exceptions anſwered by Mr. Newton. Phil. Tranſ. N° 128. p. 698.

IT is no wonder, that Mr. *Lucas* found the image ſhorter than Mr. *Newton* did, ſince he tried the experiment with a leſs angle; and that it might appear experimentally, how the increaſe of the angle encreaſes the length of the image: Mr. *Newton* tried the experiment with ſeveral angles, and the trials are ſet down in the following table; where the firſt column expreſſes the angles of two priſms, which he uſed, meaſured as exactly as he could, by applying them to the angle of a ſector; and the ſecond column expreſſes in inches, the length of the image made by each of thoſe angles; its breadth being two inches, its diſtance from the priſm 18 feet and 4 inches, and the breadth of the hole in the window-ſhutter ¼ of an inch.

	Angles		Lengths			Angles		Lengths	
The firſt priſm	56°	10′	7	¼	The ſecond priſm	54°	0′	7	⅗
	60	24	9	½		62	12	10	⅓
	63	26	10	⅓		63	48	10	¾

It may be perceived that the length of the images, in reſpect of the angles that made them, are ſomething greater in the ſecond priſm than in the firſt; but that was owing to the greater refractive power of the glaſs of the ſecond priſm: The days on which theſe trials were made, being not ſo very clear as Mr. *Newton* could wiſh, he repeated the experiment with the ſecond priſm on as clear a day as he could deſire, and found the lengths of the image, made by its ſeveral angles, to be about ¼ of an inch greater than before; the meaſures being theſe ſet down in the table.

	Angles		Lengths	
The ſecond priſm	54°	0′	7	⅓
	62	12	10	½
	63	48	11	

The reaſon of this difference might be, that in the cleareſt days, the light of the white ſky, which dilutes and renders inviſible the fainteſt colours at the ends of the image, is a little diminiſhed in a clear day, and thus it ſuffers the colours to appear of a great length, the ſun's light at the ſame time becoming briſker, and ſo ſtrengthening the colours, and making the faint ones at the two ends more conſpicuous; for Mr. *Newton* obſerved, that in days ſomething cloudy, whilſt the priſm has ſtood unmoved at the window, the image would grow a little longer or a little ſhorter, according as the ſun was more or leſs obſcured by thin clouds paſſing over him; the image being ſhorteſt while the cloud was brighteſt, and the ſun's light fainteſt: Whence it is eaſy to apprehend, that if the light of the clouds could be quite removed, ſo that the ſun might appear ſurrounded with darkneſs; or, if the ſun's light were much ſtronger than it is, the colours would ſtill appear to a greater length: In all thoſe obſervations, the breadth of the image was juſt two inches; but Mr. *Newton* obſerving, that the ſides of the two priſms he uſed, were not exactly plane, but a little convex, the convexity being much about that of a double-convex glaſs of a 16 or 18 foot teleſcope; he took a third priſm, whoſe ſides were as much concave,

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cave, as thoſe of the other were convex; and this made the breadth of the image to be $2\frac{1}{3}$ inches; the angles of this priſm, and the length of the image were thoſe expreſſed in this table,

Angles	Lengths
58°	$8\frac{1}{2}$
$59\frac{1}{2}$	9
$62\frac{1}{2}$	$10\frac{1}{3}$

In this caſe, the concave figure of the ſides of the priſm, by making the rays diverge a little, encreaſed the breadth of the image in proportion to its length more than it would be otherwiſe; and not only the different figures of priſms, but alſo the different refractive power of glaſſes, the different diameters of the ſun at different times of the year, and the little errors that may happen in meaſuring lines and angles, or in placing the priſm at the window, may cauſe ſome difference in theſe trials: One thing more is to be added, *viz.* that the utmoſt length of the image, from the fainteſt red at one end, to the fainteſt blue at the other muſt be meaſured; ſometimes there will happen to ſhoot out from both ends of the image a glaring light a good way beyond thoſe colours; but this is not to be regarded, as not belonging to the image: If the meaſures be taken right, the whole length will exceed the length of the ſtraight ſides by about the breadth of the image.

The main thing Mr. *Lucas* goes about to examine in his experiments, is, the different refrangibility of light; and this is demonſtrated by the *Experimentum Crucis*; now, if this demonſtration be good, there needs no further examination of the thing; if otherwiſe, its defect is to be ſhewn; for the only way to examine a demonſtrated propoſition, is to examine the demonſtration.

And it is proper to obſerve, that the *Experimentum Crucis*, and ſuch others as ſhall be made for diſcovering the nature of colours, be made with priſms that refract ſo much, as to make the length of the images five times their breadth, and rather more than leſs; for otherwiſe, experiments will not ſucceed ſo plainly with others, as they have done with Mr. *Newton*.

As to Mr. *Lucas*'s experimental diſcourſe, it is ſufficient in general to obſerve, that it has proceeded partly from ſome miſunderſtanding of what he writes againſt, and partly from want of due caution in trying experiments: However, Mr. *Newton* declares himſelf much obliged to Mr. *Lucas* for taking theſe things ſo far into conſideration, and being at ſo much pains in examining them; and that the more, as he has been the firſt who ſent him an experimental examination of them.

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Obſervations in Aſia; *by M.* Tavernier. Phil. Tranſ. N° 129. p. 711.

*I*Spahan is about the bigneſs of *Paris*, but ten times leſs populous: The air of *Gomron*, a ſea-port town in *Perſia*, from *April* to *November* is ſo unwholeſome, that it breeds a very malignant fever, which, if it kill not, leaves behind it the jaundice for the reſt of the patient's life: After the end of *March*, the wind changes, blowing moſtly from the weſt, or ſouth-weſt, and is ſometimes ſo hot and ſuffocating, as to take away reſpiration; whence the *Arabians* call it *El-Samiel*, that is, a wind of poiſon; and which is very extraordinary, if any one lay hold on any part of a body, that hath been newly ſtifled by this wind, it remains in the hand like greaſe, and as if the body had been dead a month before; there is the ſame kind of air about *Mouſſel* and *Bagdat*; and M. *Tavernier* relates, that traveling with ſome *Arabian* merchants, as ſoon as they perceived this wind coming, they threw themſelves flat upon the ground, covering themſelves well with their cloaks, and in this poſture they continued till the danger was over; but when they roſe up, they found their horſes all over wet, and ſo faint, that they were not able to carry their riders; the blaſt is ſometimes ſo hot, that it burns like lightning; but it is obſerved, that upon any river this wind does no harm: In *Perſia* few children have the ſmall pox; but inſtead thereof, moſt of them are troubled with the ſcurf on the head, till they are 10 or 12 years old: The *Perſians* know nothing of the gout or ſtone; only the *Armenians*, who drink more wine than water, are afflicted with the latter: The *Perſians*, eſpecially the better ſort, are far leſs ſubject to ſickneſs than the *Europeans*, becauſe in ſpring they take a decoction of the wood of *China*, which they boil for ſeveral days in water, according to the doſe preſcribed by the phyſician, *e. gr.* the firſt day they put one ounce of it into three pints of water, increaſing the quantity of the root every day to the twelfth, and from that to the twentieth; this drink is ſaid to be very palatable, and of the colour of our pale wines; whilſt they are drinking this decoction they muſt eat nothing but a little bread, and a roaſted chicken without ſalt; and after they have done drinking, they muſt forbear eating fruit a whole month; when this drink is taken, the perſon muſt be very well covered to ſweat; which he does plentifully, and all his linnen becomes yellow, and even the walls of his chamber: This root ſoon ſpoils, and when it is good, the author ſaith, a pound of it coſts 100 crowns: All the women of the *Turkiſh* ſeraglio are always chawing maſtick to keep their teeth clean and white: When the *Nogaies*, a ſort of *Tartars*, have received any wound, they uſe no other ointment but boiled fleſh, applied hot to the wound; and when the wound is deep, they thruſt in a piece of fat as hot as the patient can bear it; and for this purpoſe, the fleſh and fat of horſes are reckoned the beſt: Such as are troubled with the cholic, are ordered to eat horſe-fleſh, which is ſaid to cure many: Near the iſle of *Baharen*, they fetch freſh water from the bottom of the ſea; about cape *Comorin*, and along the coaſt of *Coromandel* and *Malabar*, where there is no freſh water, the people come with veſſels at low water as near the ſea as they can, and digging about two foot in the ſand, they meet with freſh water fit for drinking: Camels go with young 11 months, and can be without drinking for many days, even for 9 days; the larger ſort of them can carry from 1000 to 1500 pound weight; their milk is a ſovereign remedy againſt the dropſy: The cows about *Balſara* having no graſs to feed on, are fed with the heads of fiſh and dates boiled together: The palm-trees in the country of *Balſara* are propagated in the following manner; they dig a hole in the earth, in which they range 250 or 300 date-kernels, one a-top of the other like a pyramid, with the points upwards, ſo as that the pyramid ends in one kernel; which being covered with earth, the tree grows up: Craw-fiſh creep up on high white mulberry-trees about ſun-ſet, and eat the fruit; and at break of day come down again into the rivers, near which theſe trees grow: Porcupines kill lyons by darting their quills into their bodies: All along the gulph of *Perſia* there are vaſt numbers of a kind of locuſts, which are eatable; and M. *Tavernier* affirms, he opened one that was 6 inches long, and found 17 young ones in its belly, all of them moving: There is a talc in *Perſia*, which beaten into pieces, as ſmall as lentils, and tinged with any colour, and mixt well with chalk, if they plaiſter their walls with it, it makes them ſhine like jaſper, which is very agreeable to the eye: On the weſt of the *Caſpian* ſea, a little above *Chimaki*, is a rock yielding an oil, whereof the *Perſians* make a varniſh, by infuſing ſome maſtick in it; this oil, as it runs from the rock, is as clear as water, but afterwards it gradually thickens: The beſt glue is made of ſturgeon, it being ſo ſtrong, that you may ſooner break the thing any where elſe than where it is glued; the *Turks* prepare it thus; when they have gutted the fiſh, they meet with a certain ſkin that covers the fleſh, which is very glutinous, and twice as thick as a leaf of paper; this they roll up, and put in the ſun to dry; and when they would uſe it, they beat it with a hammer, after which they break it into ſmall bits, which they put in water in a little pot for about half an hour, and then they ſet it over a gentle fire, ſtirring it continually till it become liquid, always obſerving to keep it from boiling, which would entirely ſpoil it: The *Perſians* are exquiſitely ſkilled in damaſkeening with vitriol; the ſteel they fetch from *Golconda*, which is the only kind that can be well damaſkeened; when it is put in the fire to temper, they give it a moderate redneſs, like that of a cherry; and inſtead of quenching it in water, they only wrap it in a wet piece of linnen cloth; for if they gave it the ſame degree of heat that we do to ours, it would become as brittle as glaſs.

A Hygroſcope; *by Mr.* J. Coniers. Phil. Tranſ. N° 129. p. 715.

AAAA, Fig. 2. Plate III. is the frame of wood for the two pannels of deal-board to play loſe in at top and bottom, to which at the two ends they are faſtened; B B the two pannels of ſlit-deal, three foot deep, and three foot broad a-piece, with a diſtance left in the middle for the ſcope of the motion; C the hand fixed by the axle-tree to the plate with nail-holes, which are to faſten it to the middle of the pannel, within half an inch of the ſcope for motion; at the lower, or ſhorter end of the axle-tree is faſtened by a wire like an S, a ſmall ſilver chain within a ſtraw's breadth of the axle-tree; this chain is to be carried and placed croſs the diſtance between the two pannels, and faſtened to the oppoſite pannel by a braſs-nooſe, thro' which it is to ſlip, ſo as to be taken up or let down at pleaſure; D the roller with a wedge annexed, which by a ſtring is faſtened to the loweſt end of the hand C; ſo that, as it relaxes and gives way, the weight will adjuſt the motion of the hand to the index E; E the index of paper, paſted on the pannel oppoſite to the hand, and ſo, as in this figure, placed near the top, that the hand may move with greater advantage; and this index being but a quarter of a circle, is divided into inches more or fewer, according to the ſcope the hand of the pannels requires for their motion; but when it relaxes or ſhall require more room for the hand, then the chain is to be taken up one link more, and thus there will be more play upwards and downwards; and this taking up of the chain may be again repeated when there is occaſion, or when the time of the year requires it: Now, if the chain be placed near the axis, the motion will be nicer and larger; if farther off, then it will

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be leſs; for inſtance, the motion of two more than that of three, and three than that of four, &c. as may be ſeen by the figures, 2, 3, 4, 5, 6; which are placed in this figure below the hand.

Theſe pannels of deal-board move by ſhrinking moſt of all in ſummer, and ſwelling in winter ſeaſons, and this motion varies according to the degrees of heat or cold, moiſture or drought: That for the moſt part, eſpecially in ſpring and ſummer, this motion happens only in the day-time; for at thoſe ſeaſons, it generally reſts all night and very rarely moves: That one kind of this motion happens in dry, fair weather, but ſometimes in the former part of the forenoon, and ſometimes not until the latter part of the forenoon, and then it relaxes or ſwells the deal for about two or three hours more or leſs; and all the afternoon it ſhrinks, ſometimes even when a ſmall rain has newly fallen, or is then falling; but this not ſo often, and more ſeldom in winter or cold moiſt weather: This ſhrinking is very often gradual, and for the moſt part a little after moiſture; *viz.* the firſt day it ſhrinks a little, the ſecond day more, and ſo ſtill more according to the time of the year; and as it is then inclined to moiſture or drought, heat or cold: When the winds are at north, north-eaſt and eaſt, both winter and ſummer, generally the deal ſhrinks as well by night as by day, but not ſo much; which is a ſign of drying weather, and ſometimes of froſt or cold in winter, ſcorching heat in ſummer in a clear day: But on the contrary, the ſouth winds blowing, or the weſt and ſouth-weſt, the deal always relaxes, or at leaſt is at a ſtand, providing it happen in the day-time; for if in the night not ſo much, and it will do ſo ſome conſiderable time before rain: By conſtantly obſerving this experiment of the deal's motion and reſt, you may be able to gueſs at the ſituation of the wind without a weather-cock, providing you have a common and ſealed thermometer: You may alſo know the time of the year; for in the ſpring it moves quicker, and more than in winter; in ſummer it ſhrinks more than in ſpring; in autumn it is leſs in motion than in ſummer.

In a ſecond contrivance, A A A A Fig. 3. is the frame of wood for the pannels of deal to play looſe in, at the top and bottom; B B B B the croſſes of the deal or iron faſtened to the frame on each ſide, to which is annexed the circular index divided into 12 parts, in the centre of which the axis *b* for the hands is placed; C C the two pannels of ſlit deal, three foot deep and three foot broad each, faſtened at each end of the frame, with a diſtance left in the middle for the ſcope of the motion: The inward work is thus contrived; A A Fig. 4. the two hands; B B the two braſs pullies or rollers, the one bigger, the other leſs; to the bigger a flat leaden weight is faſtened with a cat-gut ſtring; to the ſmaller is faſtened a ſmall ſilver chain, which is to be fixed by the nooſe or loop of braſs C to the pannel under the middle of the croſs, near the gap or ſcope for the motion; and the chain by a faſtening in the nooſe is to be taken up or let down at pleaſure; D the roller or pulley to be placed on the other pannel oppoſite to the nooſe, and near the gap or ſcope between the two pannels; and the ſmall chain, upon its return to the axis is to be placed over this roller, E the axis upon which the two rollers or pullies B*b* are to be faſtened, and the two hands A A for the index; F the weight annexed to the biggeſt pulley B, and the ſtring or cat-gut to be moved the contrary way to the ſmall pulley on which the ſilver-chain is faſtened; ſo that as the ſhrinking of the pannel moves the axis one way, the relaxing may move the hands or axis the other way, by means of the weights: The circumference of the ſmalleſt pulley or roller *b*, is to be no bigger than juſt the ſcope or diſtance of the extremity of the two pannels in their utmoſt ſwelling or ſhrinking; and ſo one full revolution of the hand upon the index may anſwer the greateſt ſhrinking and ſwelling in a whole year, and the diſtance between the two rollers or pulleys fixed on the axis muſt be the thickneſs of your pannels; ſo that the weight is to play or move on the one ſide of the pannel, and the chain on the other without diſturbance or rubbing againſt the ſides of the pannel or the croſs, between which they are to be placed out of ſight.

The deal-board ſhould be of the fineſt, and ſtraighteſt grained dram-deal, laid to dry for two or three years; and in order to know, whether it be ſufficiently ſeaſoned, take a ſmall piece thereof, and weigh it in a nice pair of ſcales, and if you find its weight not encreaſed many grains in wet weather, nor decreaſed in dry, you may conclude it fit for your purpoſe.

Of the Trochitæ *and* Entrochi; *by Mr.* J. Beaumont. Phil. Tranſ. N° 129. p. 724.

ALL the *Trochitæ* and *Entrochi* deſcribed by Dr. *Liſter*, are found in *Mendip-hills*, except that figured like a fruit, and Mr. *Beaumont*'s obſervations do generally agree with thoſe of Dr. *Liſter*; he found the joints of that ſpecies of *Entrochi*, which are tapering at both ends, and which ſwell in the middle, to be of the ſame make; ſo that an *Entrochos* appears like a number of little barrels, laid one on another: Their cavities are of all ſizes; ſome of them are ſo hollow, that there is only a thin ſhell left, ſmooth both within and without; others have a thin ſhell, but with windings on the inſide and out; and ſometimes both theſe are one entire piece with ſeeming ſutures; the cavities according to Dr. *Liſter* are generally round, but Mr. *Beaumont* had ſeveral ſingle joints and *Entrochi* with hollows like a cinquefoil, and theſe ſeem moſt natural to the *Radix*, which has five ſtirts or feet iſſuing ſideways from it; and he found in ſome pieces of roots a ſmall furrow paſſing inwardly from each foot to the top of the ſtone, with a ridge on its outſide, beſides a new ſpecies of *Trochitæ* and *Entrochi* with ſix inlets into the cavity, as the latter have but five; but with this difference, that theſe inlets terminate in angles, ſo that it is a ſexangular hollow, whereas the cinquefoil-inlets are round like that leaf, and not pointed, tho' he had ſeen ſome even of theſe with ſharp angles: Several rays ſhooting from a centre to a circumference muſt leave conſiderable ſpaces between them, proportionable to the bigneſs of that circumference, to fill up which, betwixt two rays there iſſues about half way from the centre a third, which ſhoots to the circumference; ſome have their rays widening gently from the centre to the circumference; others have a trunk riſing from the centre, which grows forked towards the circumference; and ſometimes between theſe forks there ariſes a ſmall ray near the trunk where the forks join, which ſhoots to the circumference; but it is to be obſerved, that theſe differences are ſcarce diſcernible, without a glaſs, where the rays are fine; others again are branched, with a trunk riſing from the centre, and three, four or five branches ſhooting to the circumference; ſome are ſmooth half-way from the centre, with a circle of ſmall rays near the circumference; and ſome are ſmooth without any rays, theſe are commonly pretty thick, and are joined into an *Entrochos* in this manner; in a *Trochite* a little within the outward circle on the upper and lower parts, where the rays uſe to be, are round inlets or ſockets, which are pretty deep, ſo that only a thin *Tympanum* hinders, otherwiſe the *Trochites* would be hollow at this width all over; in the middle of this *Tympanum* is a hole, as in other *Trochites*, which is ſometimes round, and ſometimes like a cinquefoil; the *Trochites*, that anſwer this on both ſides, have ſmooth joints entring into theſe ſockets, and theſe joints are alſo hollow, and thus other *Trochites* with ſockets are joined to theſe to make up the *Entrochos*; ſome of theſe have both ſockets and rays, others have a ſocket on the one ſide, and rays on the other without a ſocket; ſome are all ſmooth, with only a ſmall ridge running round them a little within the outward circle, which enters into a ſmall furrow anſwering to it; others are all ſmooth and joined only *per harmoniam*; ſome *Trochites* are of an equal ſubſtance or thickneſs from the centre to the circumference; others are pretty thick in the circumference, and grows thinner towards the centre; ſo that they have concavities on both ſides, to which convexities in other *Trochites* anſwer; ſome are of an equal thickneſs half way from the outward circle, and then they grow concave toward the centre: Mr. *Beaumont* found ſome *Entrochi*, as well as *Trochites* of an oval figure, and their bores alſo oval; and ſome *Trochites* of this kind have no rays, but are joined together only by one ridge paſſing directly along the middle of the ſtone, with a furrow in the other anſwering thereto: There are ſome ſingle joints with a double oval; the oval in the upper part ſtands directly contrary to that in the lower; in others again the ovals ſtands awry, like a St. *Andrew*'s croſs; and there are alſo *Entrochi* made up in this manner, and moſt of the oval ſort grow crooked and twiſted.

Agricola compares thoſe ſtones, called *Radix*'s, to a wheel, and its body does well reſemble the nave of a cart or coach, it being conical towards one end, where its a little flat with a hole in it; and it has another hole in the middle of the broad end juſt oppoſite to the former, and the five hollow ſtirts or feet iſſuing ſideways at equal diſtances from the broad bottom, ſomewhat reſemble ſpokes; at the ends of the five ſtirts or feet, there grows juſt over the middle of the hollow, from the upper to the lower part of the ſtirt, a pretty large ſeam, dividing the hollow in the middle, and covering about a third part of it, but entring no farther into the hollow than its mouth, ſo that the hollow of each ſtirt preſents itſelf with two eyes; hence it appears that theſe ſtirts or feet were never longer than they are, and that no ſtone ever grew to them; the ſtone is compoſed of trigonal, tetragonal, pentagonal and hexagonal plates; the upper part of the conical end is wrought round with large hexagonal plates, and theſe reach half way the ſtone; then follows a ſecond round made up of pentagonal plates pretty large, and theſe reach almoſt to the broad bottom, which is a little convex, the bottom and feet conſiſt of plates of all ſizes, but moſt of them are very ſmall: This ſtone is in ſubſtance a whitiſh opake *Fluor*, of the ſame nature with the *Trochites*; it has outwardly a ruſty coat, and is blueiſh within like ſome ſea-ſhells; it is full of a ſort of aſh-coloured griſty clay, to which it evidently owes its original, being found in a bed thereof; the ſhell-like and ſparry ſubſtance is ſcarce as thick as half a crown.

Mr. *Beaumont* found the *Trochitæ* ſticking to rake-mould-ſtone, and in the crannies of rocks at all depths to 20 fathoms; he alſo found a fruit with them like a *Lapis Judaicus*, about the bigneſs of an acorn, with ridges and furrows running lengthwiſe; it is in ſubſtance a whitiſh opake ſpar, like the *Trochites*; ſome are of a white cawky ſubſtance, and ſome have a tincture of red; but theſe differences proceed from the clay of which they are made; for tho' the aſh-colour be the chief, yet there are ſome veins of red, ſome of white, ſome of a light blue, and ſome of a dark blue, *&c.* which cauſe theſe varieties in the ſtones: Some *Trochitæ* and *Entrochi* are ſhaped in a raw clay, before they have attained the conſiſtency of a ſtone; and theſe, if laid in the ſun, become light and ſpungy like a pumice-ſtone; he alſo found a hollow ſtone of a ſparry ſubſtance, about the bigneſs of a walnut, and filled with the ſaid clay; it ſomewhat reſembled a helmet, its fore-part was ſmooth; the upper part, which had a large ridge in the middle, was wrought with little rings, three in the ſame place, and incloſed within each other. The ſtone called *Cornu Ammonis*, ſhaped like a ram's horn, is very frequent in this clay; their texture is as follows; ſome have maſſy ſpar in their inſides, which makes up three parts of the ſtone; then from the ſharp top there grow thin flat cells, or ſmall pipes of ſpar, ſet edge-wiſe one cloſe to the other, all round the ſtone, which ſhoot towards the broad end, and appear outwardly like ſmall ridges or ſeams; and many of theſe pipes running down diſcover their hollows, ſome at one place, and ſome at another, and ſome not till they come to the broad end; and they have rings alſo running round them towards the broad end, tho' ſomewhat defaced: Moſt of the leſſer have very little maſſy ſpar within them, and ſome have none, but appear ſomewhat hollow at the broad end, with cells running down internally from the top of the ſtone, reſembling thoſe in the flowers of coral, which terminate its branches; and doubtleſs, if taken from their beds in a ſeaſonable time, would yield the like milky juice; for in the cells of ſome broken pieces, an evident concretion of ſuch a milky juice is found; and Mr. *Beaumont* found a piece of a branchy ſpar in a mine, growing like coral, and terminated with buttons or flowers in the ſame manner; the cells in the ſmaller *Cornu Ammonis* appear only inwardly, with one outward coat which covers

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them all, which in ſome is ſmooth, in others wrought with little rings like the helmet-ſtone above-mentioned; and ſome outſides have ridges or rings around them like a ram's-horn: The ſtones generally move in vinegar, juice of lemons, *&c.* emitting bubbles, as cawk is found to do very freely, and moſt mineral ſtones.

Mr. *Beaumont* found a mine, where almoſt all the *Entrochi*, or bodies of rock-plants grew tapering and branchy; ſome of them with branches near two inches long, and other ſmall branches ſpringing from theſe; he alſo found, that all the clifts in ſome mines are made up of theſe ſtone-plants; in the courſes, or loads betwixt the clifts, theſe plants grow up in the griſty clay mentioned above, being rooted on the rake-mould ſtones, many of them above a foot in height, and about the bigneſs of the ſtem of a tobacco-pipe; and they are either raw clay, or of the conſiſtence of a lime-ſtone, and ſome of them have outwardly evident beginnings of circles and ſutures; the ſmall plant which is entire, and the branched bodies of many others have attained their full term of growth, being become perfect ſpar; the branches are all jointed, and have the ſame bore with the trunks, and are terminated with ſmall round and blunt joints; the bores, or hollows, are commonly filled with a milky curdled ſubſtance, which probably in their time of growth was fluid as that in coral; and as many of thoſe plants grow on *Radixes*, ſo many of them grow from plain roots, that is, from plain ſpar, or lime-ſtone: Theſe plants do not always grow up with one trunk or body, but ſometimes five or ſix ſprouts, nearly of an equal bigneſs, ſhoot up together from the ſame root, as is uſually the caſe in coral; ſome of them have only four inlets into their cavity, and others ſeven; ſome have a circular edge on every joint, the intermediate joint being ſmooth without edge or knot; ſome trunks have circular edges on the middle of every joint; but in ſuch a manner, that the firſt and fifth edges are the higheſt; the ſecond and fourth the loweſt; the third is higher than the latter, and lower than the former, the joints themſelves being great and ſmall accordingly, and this order holds all over the plant; ſome trunks have edges according to the ſame order, only thoſe on the ſecond and fourth joints are round and blunt, the other three being ſharp; others have edges in the ſame order, all round and blunt; there are ſome trunks wrought in the ſame manner, only the firſt and fifth joints have a circle of knots round them, the other three have edges; ſome trunks have neither circles nor knots, but are only a little rough, like the plates which compoſe ſome roots; but notwithſtanding their different figures, the texture of their ſubſtance appears to be wholly the ſame: Theſe rocky plants begin their growth from the fineſt parts of clay, being commonly white, ſoft and ſmooth at firſt; and by degrees come to have ridges, knots, and ſutures, as they tend towards a ſtony, and ſo to a ſparry nature: The pith continues ſtill ſoft and white, as the whole is at firſt, and it is continually refreſhed by mineral ſteams and moiſture, which have free acceſs to it thro' the five hollow ſtirts or feet, in the figured roots, or thro' the maſs of clay, which commonly lies under the plain roots; nor can theſe plants be denied true life and growth, ſince they have inward pith and ſap, as alſo joints and ſometimes cells, which may very well ſupply the place of veins and fibres; and it is probable, that theſe rock-plants are ſtones of their own kind, and not parts of plants or animals petrified.

Of the Lake *of* Mexico, *and of a Sort of* Rye *in* France. Phil. Tranſ. N° 130. p. 758.

THE lake of *Mexico* hath ſomething extraordinary, and perhaps peculiar to itſelf, *viz.* that part of its water is freſh and part ſalt; which is the reaſon that it is thought to be derived from two ſources, the one of ſweet water, and the other from ſome mineral and ſaline earth found in the hills thro' which this water paſſes, being impregnated with the ſalt which it diſſolves in its courſe; or, if it have no peculiar ſource, the bottom of the earth there muſt be full of ſalt; which is confirmed by experience, much ſalt being made thereof, of which a great trade is carried on to remote parts, even as far as the *Philippines*, whither it is tranſported in conſiderable quantities; that part of the lake which is ſweet, is ſtill and quiet; the ſalt part is agitated and moved according as the wind blows; the freſh water is very good and wholeſome, breeding plenty of ſmall fiſh; that, which is agitated is bitter ſalt, breeding no fiſh at all; the ſweet water is higher than the other, and falls into it; the water of the ſalt part is 7 leagues long, and as many broad, and above 22 in compaſs; that of the freſh water is near as large; and the whole lake about 50 leagues in compaſs.

M. *Perrault* travelling thro' *Sologne*, was informed by ſome phyſicians and ſurgeons of that country, that the rye there was ſometimes ſo corrupted, that ſuch as did eat of the bread wherein there was much of this rye, were ſeized with a gangrene; theſe grains of rye thus degenerate appear black without, and pretty white within, and when dried they are harder and cloſer than the natural good grain, without any ill taſte; ſome of the grains have a ſubſtance reſembling honey both in taſte and conſiſtence hanging from them; they become much longer in the ear than the other; ſome of them being 13 or 14 lines in length, and 2 lines in breadth, and at times 7 or 8 of them are found in one ear.

Rye doth in this manner degenerate in *Sologne*, *Berry*, the country of *Blaiſe* and *Gaſtinois*, and almoſt every where, eſpecially in light and ſandy ſoils; it grows plentifully in wet years, and moſt of all when exceſſive heats enſue upon a rainy ſpring; the bread made of the rye, which contains ſome of this grain, taſtes like other bread; it produces its effects chiefly when new, yet not till it has been uſed a conſiderable time; which are, to dry up the milk in women, to cauſe ſometimes malignant fevers, accompanied with drouſineſs and raving, to breed the gangrene in the arms, but generally in the legs, which it firſt ſeizes, as the ſcurvy does; it is preceeded by a certain numbneſs in the legs, upon which enſues a little pain and ſwelling without inflammation, and the ſkin becomes cold and livid; the gangrene begins in the centre of the part, and appears not at the ſkin till a long time after; the only remedy is to cut off the affected part, which if not done, the part becomes dry and lean, as if the ſkin were dried over the bones; and it is of a frightful blackneſs, without any rottenneſs; whilſt the legs are drying up, the gangrene aſcends to the ſhoulders; there is yet no ſpecific remedy againſt this diſtemper; there is ſome hopes of preventing it by hot ſpirits and volatile ſalts; the orvietan and ptiſan of lupins do conſiderable ſervice; poor people are generally only afflicted with it; ſome of this grain was given to ſeveral animals, and they all died of it.

A ſubterraneous Fire *in a Coal-Mine near* Newcaſtle; *by Dr.* Lucas Hodgeſon. Phil. Tranſ. N° 130. p. 762.

THIS ſubterraneous fire bears no analogy to other vulcano's; it encreaſes and decreaſes according to its fuel, which is for the moſt part a day-coal, that is, the upper ſeam of the coal immediately expoſed to the air, ſo that you may light a candle at it in ſome places, in other places it is ſome fathoms deep: There is no ſal-armoniac, nor any thing like it to be found, except where there is an actual fire: The ſteams of ſal-armoniac and ſulphur riſing together in moſt places, it is hard to diſtinguiſh them; for tho' the flowers of brimſtone ſeem to riſe firſt, yet there is commonly a cruſt of ſal-armoniac under them: The milky ſubſtance is only found in thoſe places where the ſal-armoniac and ſulphur are totally waſted; and the acid part, or alumi-

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aluminous ſpirit of that white maſs, will alſo evaporate by the encreaſe of the fire, and leave a dry, ſtyptic *Caput Mortuum*, and as hard as a ſtone; yet a pound of this maſs, before it has too much undergone the action of the fire, will nearly afford by ſolution, *&c.* half a pound of tolerable cryſtalline allum: The neighbouring ſoil differs little from other ground, having neither common ſalt nor nitre in it: The ſprings that are near the fire do not diſcover the leaſt ſigns of ſal-armoniac: The water from the adjacent collieries is vitriolic, giving as deep a tincture with galls as *Scarborough* ſpaw, and differs in nothing from the ordinary water of collieries; the other ſprings contain no mineral ſalt: Dr. *Hodgeſon* gathered ſal-armoniac from a burning brick-kiln, where nothing but clay and coal were burnt together: There is a ſort of a mineral called a ſlate, partly coal, partly allum-ſtone, and partly marcaſite, which, laid up in heaps and burnt, are uſed for hardening the coal-ways; from theſe heaps, whilſt burning, both ſulphur and ſal-armoniac are often gathered: Upon pouring cold water on powdered marcaſite, a vitriolic water, but no heat, was produced: It is no ways improbable, that black coal ſhould yield a white ſnowy volatile ſalt, ſince all volatile ſalts whatever may be freed from their rank ſmell and intenſe colour, by tranſmuting them into a ſal-armoniac by the means of an acid, as ſpirit of ſalt, ſpirit of vitriol, allum, *&c.* and then ſubliming them till they become white: There is a cave at the diſtance of ſome miles, from whoſe roof large lumps of petrified water, like icicles, hang down, ſome of them reaching to the ground like pillars; theſe icicles are found to be good limeſtone.

Of the ſuperficial Figures of Fluids, *eſpecially* Liquors *contiguous to other* Liquors; *by Mr.* Boyle. Phil. Tranſ. N° 131. p. 775.

UPON pouring a ſtrong alcalizate menſtruum, Mr. *Boyle* uſing that of fixt nitre diſſolved by the moiſture of a cellar, into a glaſs tube, ſealed at one end, and not quite ¼ of an inch in bore, and adding ſome highly dephlegmated ſpirit of wine, immediately the figure of the ſurface of the lower liquor was changed, and the cavity quite deſtroyed, the common ſurface of the two contiguous liquors appearing horizontal or flat; and ſuch a level ſurface was obtained, upon putting theſe two liquors together into a much wider glaſs; upon uſing oil of turpentine inſtead of the ſpirit of wine, the liquor did almoſt wholly loſe its cavity; but if inſtead of deliquated tartar, you put common water into the pipe, this liquor was found to retain its concave ſurface, tho' ſome oil of turpentine was added thereto, and it was left to reſt upon the water a good while: Upon pouring a little of the gum of *Guaiacum* into a ſlender tube, its upper ſurface was concave, like what water would put on in the ſame tube; but putting a little water upon this oil, it preſently changed the figure of its ſurface, which became viſibly protuberant or convex: Having put ſome oil of tartar into the ſlender tube, and adding ſome drops of the oil of *Guaiacum*, the liquor was found not to alter manifeſtly the concave figure of the ſurface of the alcalizate liquor, as the oil of turpentine had done; and pouring a little water on the oil of *Guaiacum*, the upper ſurface of it was preſently changed from a concave figure to a convex one; ſo that this oil in the middle of the two other liquors appeared like a little red cylinder, which, inſtead of circular baſes, was protuberant at both ends; but more ſo at that end which touched the oil of tartar: Putting ſome eſſential oil of cloves into a new ſlender tube, and obſerving it to be a little concave at the top, where it was contiguous to the air, a little common water was added to it, and the ſurface of this oil became tumid: Upon pouring into a ſlender pipe ſome of the deliquated ſalt of tartar, then ſome of the aromatic oil, and laſtly, a little common water, the little cylinder of oil did, like that of the oil of *Guaiacum*, appear convex at both ends, but was unlike it in one circumſtance, that the oil of cloves appeared more convex at the upper end, where it was contiguous to the water, than at the lower, which was contiguous to the ſurface of the oil of tartar: Putting into a ſmall ſlender glaſs, that was much longer, but of the ſame bore with the former, ſome quickſilver, the upper ſurface ſwelled in the middle above the level of the parts where it touched the glaſs, but upon pouring water on it, there was a manifeſt and conſiderable depreſſion of the ſurface; and to try what variation would be made by the greater or leſſer height of the water incumbent on the mercury; ſometimes it ſeemed, that when the aqueous cylinder was much longer, the depreſſion of the mercurial ſurface was ſomewhat greater; but this did not conſtantly happen, for tho' a very little water ſufficed by its contact ſenſibly to depreſs the quickſilver, yet when there was a greater weight of water, it was manifeſtly perceived, that the ſurface of the quickſilver being depreſſed almoſt to a level in thoſe parts of it that were near the inſide of the glaſs, there was about the middle of the ſurface an elevation of mercury like a hemiſphere above the reſt of the mercurial ſurface; and to confirm this experiment the incumbent water was decanted off by little and little; upon which the hemiſphere began to be flat and ſubſided more and more, in proportion as the water was taken off: Upon conveying into a receiver a couple of ſlender tubes, one of them furniſhed with common water and the other with quickſilver, and exhauſting the air, there was no ſenſible change in the concave figure of the water; but as to the mercury, it ſometimes ſeemed to ſwell manifeſtly, and to be more protuberant upon the exhauſtion of the receiver, than when it was put in: A clear chymical oil, heavier than water, and which, when contiguous to it, had not a concave but a convex ſurface, and a tube furniſhed with both liquors was placed in the receiver, and exhauſting the air, the oil did not ſenſibly alter its protuberance, nor the water loſe its concave ſurface: Having put fixt nitre, or which is analogous to it, ſalt of tartar, diſſolved *per deliquium* into a tranſparent liquor, and filling a clear phial half full therewith, and pouring on it a convenient quantity of vinous ſpirit perfectly rectified, and letting fall gently ſome drops of oil into the ſpirit, they ſunk towards the bottom of the glaſs, till their deſcent was ſtopped by the horizontal ſurface of the alcalizate liquor of fix'd nitre; if the oily drops were but ſmall, they ſeemed to the eye ſufficiently ſpherical; for the oil differing but little in ſpecifick gravity from the ſpirit of wine, the drops did but juſt touch the ſurface of the ſubjacent alcali, and the drops being but ſmall, their own weight was not great enough viſibly to depreſs them, and hinder that roundneſs, which the preſſure of the ambient ſpirit or their own viſcoſity endeavoured to give them: If the drops were bigger, they would appear ſomewhat elliptical, the weight of the upper parts depreſſing the drops, and making the horizontal diameter longer than the tranſverſe; if a ſtill greater proportion of oil were let fall upon the heavy liquor, it would for a pretty while appear in the form of a ſomewhat imperfect hemiſphere; but if the quantity of oil were not too great, it would perhaps ſpread itſelf upon the ſubjacent liquor, and lie flat upon it, yet it would by the action of the ambient ſpirit concurring with its own tenacity, be raiſed above the ſurface of the fluid nitre, and be reduced to the figure, either of a hemiſphere or a greater ſegment of a globe, or even an imperfect ellipſis, according to the bulk or weight of the oil: Tho' theſe globules or portions of oil, did often readily mingle, when they touched each other, yet it was ſeveral times obſerved, that warily approaching them to each other, they would be made to touch without mingling, and preſs each others ſurfaces inwardly, and when ſeparated they would preſently reſume their former figure: When a large portion of oil reſted on the ſaline liquors, if then the ambient ſpirit was gently agitated, the convex part of the hemiſphere would put on various configurations: Upon putting together into a pretty large veſſel two oils with other liquors; the oils being once united, one of which was from turpentine, would not be eaſily ſeparated, but according to the prevalency of the lighter or heavier ingredient in the mixture, the compounded oil would almoſt totally either emerge to the top of the water, or lie beneath at the bottom: When oil of tartar, or nitrous alcali happened to be very clear and colourleſs, rectified ſpirit of wine would float upon it in ſuch a manner, that in moſt poſitions the phial ſeemed only to contain one uniform liquor: Upon taking deliquated alcali made of nitre and tartar, and deeply tinged with cochineel; and that the liquors might not only be heterogeneous, but differ in gravity and denſity as much as poſſible, a peculiar kind of oil, lighter than ſpirit of wine, was poured on them, and holding the plane where the two liquors were contiguous in a convenient poſition, in reſpect both of the light and the eye, it made a very vivid reflexion of the incident beams of light, ſo that this phyſical ſurface, which was flat, looked almoſt like that of quickſilver; and alſo the bright figure of the flame of a candle was ſtrongly reflected from it as from a ſpeculum.

A Continuation of Mr. Boyle's Experiments. Phil. Tranſ. N° 132. p. 799.

UPON pouring into a ſlender phial more than half full of common water a little warmed eſſential oil of aniſeeds, the upper ſurface of the latter became ſomewhat concave, as that of the water was; but the lower ſurface ſurrounded by the water was very convex, appearing almoſt like a great portion of a ſphere; then the phial was ſtopped and ſuffered to reſt for ſome time in a cold place, and the water continuing fluid, the oil of aniſeeds was found coagulated into the form it had in its fluid ſtate; but it was worth obſerving, how great a difference there was between the dull reflexion it made when coagulated, and that fine reflexion it made whilſt a liquor: Mr. *Boyle* having obſerved that quickſilver and rectified petroleum are, the former the heavieſt, and the latter the lighteſt, of all fluids, he put ſome diſtilled quickſilver into a ſmall phial, and held it in ſuch a poſture, that the incident light was ſtrongly reflected to his eye; he then gently put to it ſome petroleum, which being rectified was very clear, and he obſerved that as this liquor covered the quickſilver, there was at the imaginary plane, where they were both terminated, a briſker reflexion than the quickſilver alone had given before: Upon putting a competent quantity of a reſinous or gummy ſubſtance into a deep round glaſs with a wide mouth, and holding it by the fire in a moderate warmth, till it was reduced to a fluid ſtate, and then placing it in a receiver, and exhauſting the air by degrees, a great many bubbles appeared at the top of the liquor, and made there a copious froth; ſome of theſe bubbles were very large, and ſeveral of them were adorned with the vivid colours of the rainbow; when this ſubſtance had reſumed its conſiſtent form, ſome large bubbles were intercepted between its upper and lower ſurfaces, which had a conſiderable reflexion: It is uſually ſuppoſed that the falling drops of rain are ſpherical, but their deſcent is too ſwift for their figure to be obſerved; and what will make it the more queſtionable, is, if what is vulgarly thought be true, that hail is only rain frozen in its paſſage thro' the air; but the ſurface of water may have different figures, according as it is encompaſſed with heterogeneous fluids, or as it is only in ſome places contiguous to one or more of them; in the former caſe it is not eaſy to make an obſervation, becauſe there are not any two liquors that will not mingle with each other or with water; having therefore cautiouſly conveyed into ſome chymical oil of cloves ſome portions of common water of different bigneſſes, taking care as much as poſſible that they ſhould not touch each other; by which means, the oil being tranſparent, and yet a little coloured, it was eaſy to obſerve, that the ſmaller portions of water were encompaſſed with the oil in ſuch a manner as to be reduced into almoſt perfect globes; thoſe portions that were ſomewhat bigger, as about twice the bigneſs of a pea would be of a figure ſomewhat approaching to an ellipſis; and thoſe portions that were yet ſomewhat larger, tho' they ſeemed to be ſunk almoſt totally beneath the oil, yet they held to it by a ſmall portion of themſelves, and their ſurface was eaſily enough diſtinguiſhable from that of the oil; theſe larger portions of immerſed water, being almoſt quite encompaſſed with the other liquor, were by it reduced into a round figure, which was ordinarily ſomewhat elliptical, but more depreſſed in the middle than that figure requires; but this is to be underſtood of thoſe portions of water, that touched only the oil and the air, for ſuch as touched each other without mingling, and much more thoſe that adhered more or leſs to the ſides of the glaſs had their ſurfaces too irregular to be deſcribed: Having put into a ſlender pipe a little oil of cloves, and upon this ſome oil of turpentine, that ſo the water both above and below might be touched by heterogeneous liquors; the oil of cloves was not manifeſtly tumid at the top, nor the lower ſurface of the turpentine very convex; and from this it will be eaſy to conclude the figure of the cylindrical portion of water intercepted between theſe two oils: Having taken oil of aniſeeds thawed by a gentle heat, and common water, and putting them together into a convenient ſhaped glaſs, they were ſuffered to ſtand in a cold place, till the oil was coagulated; upon which it was ſeparated from the water, and by the roughneſs of its ſurface ſhewed, that when its parts ceaſed to be agitated, whence its fluidity did ariſe, that then the contiguous water could not inflect or otherwiſe diſpoſe them in a manner requiſite to conſtitute a ſmooth ſurface; and the caſe was the ſame in the ſurface contiguous to the air, ſave that its aſperity was different from that of the other: Mr. *Boyle* obſerved an inequality and ruggedneſs of ſurface in water, upon covering it with chymical oil of juniper, and expoſing it in very cold weather; tho' the oil continued fluid, yet the water being frozen had no longer a ſmooth ſurface, as when in its liquid ſtate it was contiguous to the oil; and the like inequality or rather a greater was obſerved on the ſurface of frozen water, which had chymical oil of turpentine ſwimming on it; and a greater roughneſs may be often obſerved in the ſurfaces of ſeveral liquors abounding in water, when, after being frozen, they have an immediate contact with the air: Upon expoſing in a large glaſs in a very cold night a ſtrong and blood-red decoction of the ſoot of wood, in the morning was obſerved a cake of ice curiouſly figured, full of large flakes, ſhaped almoſt like broad dagger-blades, but neatly fringed at the edges; and theſe figures ſeemed imboſſed, and raiſed above the level of the other ice: In the *Stellate Regulus* of *Mars*, the figure of a ſtar, or like that of the abovementioned decoction of ſoot will frequently appear imboſſed upon the upper ſurface of the *Regulus*; and the like figure has been obſerved on a maſs of *Regulus* made of antimony without *Mars*; but if to theſe two bodies copper be alſo ſkilfully added, the ſurface will be often adorned with new figures, and the moſt uſual was that of a net, that ſeemed to cover the ſurface of the compounded *Regulus*.

Of the Animalcula *in Rain, Well, Sea and* Snow-water, *as alſo in* Pepper-water; *by M.* Leewenhoeck. Phil. Tranſ. N° 133. p. 821.

M. *Leewenhoeck* diſcovered *Animalcula* or very ſmall animals in rain-water, which had ſtood but a few days in a new earthen pot glazed blue within; when they moved they exerted two little horns which were in continual motion; the ſpace between theſe two horns was flat, tho' the reſt of the body was roundiſh, and tapering a little towards the end, where was a tail near four times the length of the whole body, of the thickneſs of a ſpider's web; at whoſe extremity appeared a globule of the bigneſs of one of thoſe which made up the body; theſe little creatures, if they chanced to light upon the leaſt filament or ſtring, were intangled therein, extending their body into an oblong round, and endeavouring to free their tail; and he obſerved ſeveral hundreds of them within the ſpace of a grain of ſand: He alſo diſcovered a ſecond ſort of an oval figure, and he imagined their head to ſtand on the ſharp end; theſe were a little bigger than the former; the inferior part of their body was flat furniſhed with ſeveral very thin feet, moving exceeding nimbly, and which he did not diſcern till after ſeveral obſervations; theſe little animals did ſometimes change their figure into a perfect round, eſpecially when they came to lie on any dry place; their body was alſo very flexible; he obſerved a third ſort that were twice as long as broad, and were eight times ſmaller than the firſt, yet he obſerved little feet whereby they moved very briſkly; he further diſcerned a fourth ſort, a thouſand times ſmaller than the eye of a big-louſe; and theſe exceeded all the former in celerity; he often obſerved them to ſtand ſtill, as it were upon a point, and turn themſelves about with the ſwiftneſs of a top; he diſcovered alſo ſeveral other ſorts of animals, and they were made up as the former of globules and ſuch ſoft parts, that they burſt aſunder when they came to want water: At firſt M. *Leewenhoeck* could diſcern no living creatures in rain-water, only he obſerved many irregular terreſtrial parts; yet in ſome time after he diſcovered a few exceeding ſmall animals; and he imagines that many thouſands of theſe little animals do not equal an ordinary grain of ſand in bigneſs; and comparing them with a cheeſe-mite, he makes the proportion between them to be, as that of a bee to a horſe; for the circumference of one of theſe animals in water is not ſo great as the thickneſs of a hair in a cheeſe-mite: In another quantity of rain-water expoſed for ſome days to the air he obſerved a thouſand of them in one drop of water, which were of the ſmalleſt ſort he had hitherto ſeen; and in ſome time after he obſerved others eight times as big, almoſt of a round figure: In the water of the river *Maeſe* he found ſuch ſmall animals that he could hardly diſcern their figures; but their number was far leſs than that in rain-water: In the water of a very cold well he diſcovered a great number of very animals, which were exceeding clear: In the winter he obſerved none of theſe *Animalcula*, nor any of them this year, *viz.* 1676 before the month of *July*, and then they appeared not very numerous; but in *Auguſt* he obſerved them in great plenty: He obſerved at firſt in ſea water a little blackiſh animal, which ſeemed to conſiſt of two globules; this animal had a peculiar motion reſembling the ſkipping of a flea on white paper; he alſo diſcovered ſmall clear animals of the ſame ſize with the preceeding, but of an oval figure and winding motion; he further obſerved a third ſort, which were very ſlow in their motions; their bodies were of a mouſe-colour, and clear towards the oval point; and before the head and behind the body there ſtood out a little ſharp point; this ſort was a little bigger; and there was a fourth ſort ſomewhat longer than oval; yet of all theſe ſorts there but a few of each, ſo that in a drop of water he could obſerve ſometimes no more than three or four, ſometimes one only; in ſome days after, viewing this water, he ſaw a hundred where before he obſerved but one; but theſe were of a different figure, and not only ſmaller, but very clear, and of an oblong oval figure, with this only difference that their heads appeared to end ſharper; and tho' they were a thouſand times ſmaller than a ſmall grain of ſand, yet when they lay out of the water in a dry place, they burſt in pieces and divided into three or four very ſmall globules: M. *Leewenhoeck* put ⅓ of an ounce of whole pepper into water, in which lying for about three weeks, and twice adding ſnow-water thereto, the other water being in great part evaporated, he obſerved in it to his ſurpriſe an incredible number of ſmall animals of ſeveral kinds; and among the reſt, ſome that were three or four times as long as broad, but their whole thickneſs did not much exceed that of the hair of a louſe; the ſecond ſort diſcovered in this water were of a perfect oval figure, and they moved nimbly as the former alſo did, and theſe were more numerous; there was a third ſort which exceeded the two former in number, and they had alſo tails like thoſe he formerly obſerved in the rain-water animals; the fourth ſort were incredibly ſmall, ſo that if a hundred of them lay ſide by ſide, they would not equal the length of a grain of coarſe ſand; and according to this eſtimate, ten hundred thouſand of them could not equal the dimenſions of a grain of ſuch coarſe ſand; he alſo diſcovered a fifth ſort, which had near the thickneſs of the former, and were almoſt twice as long: He could not obſerve in ſnow-water which had ſtood for three years in a glaſs bottle well ſtopped any *Animalcula*; and pouring ſome of it into a tea-cup upon half an ounce of whole pepper; it was ſome days before he obſerved any animals therein, and they were exceeding ſmall, and their bodies ſeemed to be twice as long as broad, but they moved very ſlowly, and often circularly; he obſerved alſo a vaſt number of oval animals, even 6 or 8000 in one drop.

Obſervations on two Satellites *of* Saturn; *by M.* Caſſini. Phil. Tranſ. N° 133. p. 831.

THE outmoſt *Satellite*, which is diſtant from the centre of *Saturn* 10 ½ diameters of his ring, revolves in 80 days, ſo juſtly, that he doth not anticipate nine revolutions, which are made in two years, but by one whole day; and in the conjunctions with *Saturn*, his latitude encreaſes according as the ring of *Saturn* enlarges itſelf; tho' the line of his motion is not parallel to the circumference of the ring; after ſeveral revolutions of this ſatellite it is obſerved to have a period of apparent augmentation and diminution, by which period he becomes viſible in his greateſt occidental digreſſion, and inviſible in his greateſt oriential digreſſion; he begins to appear two or three days before his conjunction in the inferior part, and to diſappear two or three days after his conjunction in the ſuperior part; ſo that he remains inviſible in every revolution of 80 days for a whole month together: This viciſſitude of phaſes makes it ſeem probable, that one part of his ſurface is not ſo capable of reflecting to us the ſun's light, as the other part is; whence it may be conjectured that the globe of the ſatellite has ſome diverſity of parts analogous to that of the earth, one part of whoſe ſurface is covered with ſea, which is not ſo fit to reflect light as the continent which conſtitutes the other part; ſo that this planet by a converſion about his axis, or by an obverſion of the ſame hemiſphere, much after the manner of the moon to the earth, ſometimes turns to us the part analogous to the continent, and ſometime that which anſwers to the ſea.

The greateſt digreſſion of the third ſatellite of *Saturn* from his centre is only found one $\frac{2}{3}$ of the diameter of his ring, and the period of his revolution is 4 days 12 hours 27 min. his latitude alſo encreaſes as the ring enlarges; and this ſatellite being alternately one day towards his conjunction, and the other day towards his digreſſion, he is ordinarily ſeen only every third day, and rarely two days together, unleſs at the hour of obſervation he be in the middle betwixt the conjunction and digreſſion.

Of the trembling of Conſonant Strings; *by Dr.* Wallis. Phil. Tranſ. N° 134. p. 839.

IT hath been long ſince obſerved, that if a viol or lute-ſtring be touched with the bow or hand, another ſtring on the ſame, or another inſtrument, not far from it, if an uniſon to it, or an octave, or the like, will at the ſame time tremble of its own accord; but Dr. *Wallis* further adds, that not the whole of that other ſtring doth thus tremble, but the ſeveral parts ſeverally, according as they are uniſons to the whole, or the parts of that ſtring ſo ſtruck; for inſtance, ſuppoſing A C Fig. 4. Plate III. an upper octave to $\alpha\gamma$, and therefore an uniſon to each half of it, ſtopped at β; now if A C be ſtruck, while $\alpha\gamma$ is open, the two halves of this latter, that is $\alpha\beta$ and $\beta\gamma$ will both tremble, but not the middle point at β; which will eaſily be obſerved, if a little bit of paper be lightly wrapped about the ſtring $\alpha\gamma$, and removed ſucceſſively from one end of the ſtring to the other: In like manner if A D Fig. 5. be an upper twelfth to $\alpha\delta$, and conſequently an uniſon to its three parts equally divided in β, γ, and if A D be ſtruck, while $\alpha\delta$ is open, its three parts $\alpha\beta$, $\beta\gamma$, and $\gamma\delta$ will ſeverally tremble, but not the points β, γ; which may be obſerved in like manner as the former: Alſo, if A E Fig. 6. be a double octave to $\alpha\varepsilon$, the four quarters of this latter will tremble, when the former is ſtruck, but not the points, β, γ, δ: So if A G Fig. 7. be a fifth to $\alpha\eta$, and conſequently each half of the former be ſtopped in D, an uniſon to each third part of the latter ſtopped in γ, ε, while that former is ſtruck, each part of this latter will tremble ſeverally, but not the points γ, ε, and while this latter is ſtruck, each part of the former will tremble, but not the point D; the like will hold in leſſer concords, but the leſs remarkably as the number of diviſions encreaſes: This phænomenon, as far as is known, was firſt diſcovered by Mr. *William Noble* of *Merton* college, and after him by Mr. *Thomas Pigot* of *Wadham* college, and this is now commonly known to muſicians: Dr. *Wallis* adds, that the ſame ſtring as $\alpha\gamma$ Fig. 4. being ſtruck in the middle at β, each part being uniſon to the other, will give no diſtinct ſound at all, but a very confuſed one; as alſo if $\alpha\delta$ Fig. 5. be ſtruck at β or γ, where one part is an octave to the other; and in like manner, if $\alpha\varepsilon$ Fig. 6. be ſtruck at β or δ, the one part being a double octave to the other; and ſo if $\alpha\zeta$ Fig. 8. be ſtruck in γ or δ, the one part being a fifth to the other, and thus in other like conſonant diviſions; but ſtill the leſs remarkably as the number of diviſions increaſes: This and the former phænomenon Dr. *Wallis* judges to depend upon one and the ſame cauſe, *viz.* the contemporary vibrations of the ſeveral uniſon parts, which make the one tremble at the motion of the other; but when ſtruck at the reſpective points of diviſions, the ſound is incongruous, becauſe the point that ſhould be at reſt is diſturbed: A lute or viol-ſtring will thus anſwer, not only to a conſonant ſtring on the ſame, or a neighbouring lute or viol, but to a conſonant note in wind-inſtruments; which was particularly tried on a viol, anſwering to the conſonant notes on a chamber-organ, but not ſo remarkably to the wire-ſtrings of an harpſichord: Wind-inſtruments communicate to the air as ſtrong a concuſſion, if not a ſtronger, than that of gut-ſtrings; and we feel the wainſcot-ſeats, on which we ſit or lean, to tremble conſtantly at certain notes on the organ or other wind inſtruments, as well as at the notes on a baſe-viol: Dr. *Wallis* was alſo told, that a thin, fine *Venice* glaſs was cracked with the ſtrong and laſting ſound of a trumpet or cornet, ſounding near it an uniſon or a conſonant note to that of the tone or ting of the glaſs, and he thinks it no ways improbable.

A Man *of a ſtrange imitating Nature*; *by Dr.* Geo. Garden. Phil. Tranſ. N° 134. p. 842.

AT *Strathbogie*, not far from *Aberdeen*, there was one *Donald Monro*, who had ſomething peculiar in his temper, that inclined him to imitate unawares all the geſtures and motions of thoſe he converſed with; he had been ſubject to this infirmity from his very infancy; yet he was very loath to have it obſerved, and therefore he caſt down his eyes when he walked in the ſtreets, and turned them aſide when he was in company: He imitated not only the ſcratching of the head, but alſo the wringing of the hands, wiping of the noſe, ſtretching forth of the arms, &c. he alſo covered and uncovered himſelf as the company did, and this with ſo much exactneſs, and at the ſame time with ſuch a natural and unaffected air, that it could not be ſuſpected that he did it on deſign: Upon holding faſt both his hands, and cauſing another to make motions, he would preſs to get free; and when he was aſked how he found himſelf affected, he could only give this ſimple anſwer, *that it vexed his Heart and his Brain.*

The Manner of obſerving the Animalcula *in ſeveral Sorts of Water; by M.* Leewenhoeck. Phil. Tranſ. N° 131. p. 844.

M. *Leewenhoeck* ſuppoſed, that a drop of water did equal a pea in bigneſs, and he took a little quantity of water, of a round figure, as big as a millet-grain, and this he reckoned to be the $\frac{1}{91}$ of a pea; for when the axis of a millet-ſeed makes 1, that of a pea will make 4 $\frac{1}{2}$, whence it follows, that the ſeed of a millet is at leaſt the $\frac{1}{91}$ of a pea; this ſmall quantity of water he put into a very ſlender glaſs-tube, dividing by this means that little water into 25 or 30 parts, and thus he obſerved one part after another; and in the $\frac{1}{30}$ part of water equalling the bigneſs of a millet-ſeed more than 1000 *Animalcula* could be obſerved by an ordinary microſcope; but by that which M. *Leewenhoeck* uſed, and which he reſerved for himſelf alone, he could diſcover two or three ſorts of much ſmaller animals beſides; hence it is manifeſt, that if in the $\frac{1}{30}$ part of one millet-ſeed there be ſeen 1000, there may be ſeen 30000 in one ſuch whole ſeed, and conſequently in a drop of water, which is 91 times bigger than ſuch a ſeed, there may be ſeen 2730000: Beſides, he compared the quantity of the water to the bulk of a grain of ſand; now if the axis of a grain of ſand be 1, the axis of a drop of water is at leaſt 10, and conſequently a drop is 1000 times bigger than that ſand, and therefore there are 1000000 *Animalcula* in one drop of water, at the rate of 1000 little animals in that quantity of water.

An unuſual Meteor; *by Dr.* Wallis. Phil. Tranſ. N° 135. p. 863.

SEPT. 20th, 1676, about 7 o'clock at night, or ſoon after, there appeared a ſudden light, equal to that of noon-day, ſo that the ſmalleſt pin or ſtraw lying on the ground might be ſeen; and above in the air was ſeen, at no great diſtance, as was ſuppoſed, a long appearance as of fire, like a long arm, with a great knob at the end of it, ſhooting along very ſwiftly; and at its diſappearing, it ſeemed to ſcatter into ſmall ſparks or parcels of fire, as rockets and artificial fire-works are wont to do in the air; the flaſh was ſo ſudden, that it was ſcarcely ſeen by any but ſuch as happened then to be abroad; and it was obſerved in moſt parts of *England*; which ſhews that it was higher than it was imagined to be, or elſe it had a very ſwift motion; which made Dr. *Wallis* conjecture it to be ſome ſmall comet, whoſe trajectory paſſed very near our earth, or upon it, and might, when farther diſtant from us, appear as a comet.

Of a Pump; *by Mr.* Coniers. Phil. Tranſ. N° 136. p. 888.

AA, Fig. 9. Plate III. is the body of a ſquare taper pump made of oak, elm, or deal-planks, with a valve at bottom *aa*; BB the bucket, in whoſe middle is a valve *b*; CCC the iron to raiſe the bucket; DD the wood at the bottom of the bucket containing the valve; EE the handle for raiſing the bucket, to be managed by fewer hands than ordinary pumps are; which may be altered ſo as to employ a horſe, or mill, or other ſuch like way more advantageous than that of this handle managed by the ſtrength of men; FF a ſquare taper box with holes in the ſides, and open at bottom, in whoſe narrower part is encloſed the narrower end of the body of the pump; GG an additional bucket of a larger dimenſion, to be placed on the iron work of the pump about H, when it ſhall be needful to lengthen the taper of your pump, and thereby to raiſe the water more forcibly to a greater height; II the ſpout of the pump to caſt out the water, of the ſame breadth with the ſide of the pump; KK the iron or wooden work ſet off, or bent back, if needful, and placed behind this pump, for the eaſier and fuller motion of the pump-handle, in which it moves: This pump is 8 ½ foot long, and 1 foot 8 inches broad at top, and about 8 inches broad at bottom, where it is inſerted in the box; it throws out 8 gallons at a ſtroke, and 21 ſtrokes being made in one minute, there are 169 gallons delivered in that time; whence it is eaſy to compute, what quantity is thrown out in an hour; this kind of pump may by the ſame contrivance be made of a tree bored thro' with a taper bore; and a baſket may be uſed at the bottom of the pump inſtead of the box-colender.

Concerning the Motion of Light; *by M.* Romer. Phil. Tranſ. N° 136. p. 893.

IT has been long diſputed among philoſophers, whether the motion of light be inſtantaneous or in time; but M. *Romer*, of the Royal Academy of Sciences, hath ſhewn from obſervations on the ſatellites of *Jupiter*, that light takes up ſome time in its paſſage to us.

Let A, Fig. 10. Plate III. be the ſun; B *Jupiter*; C the firſt ſatellite of *Jupiter*, which enters into his ſhadow, to come out of it at D, and let E F G H L K be the earth placed at divers diſtances from *Jupiter:* Now ſuppoſe the earth in L towards the ſecond quadrature of *Jupiter*, hath ſeen the firſt ſatellite at the time of its emerſion, or iſſuing out of the ſhadow in D; and that about 42 ½ hours after, *viz.* after one revolution of this ſatellite, the earth being in K, doth ſee it returned to D; it is manifeſt, that if light require time to run over the interval L K, the ſatellite will be ſeen returned later to D than it would have been, if the earth had remained in L; ſo that the revolution of this ſatellite, thus obſerved by the emerſions, will be retarded by ſo much time as the light ſhall have taken in paſſing from L to K; and that on the contrary, in the other quadrature F G, where the earth, by approaching, goes to meet the light, the revolutions of the immerſions will appear to be ſhortened by ſo much, as thoſe of the emerſions had appeared to be lengthened.

This new equation of the motion of light, which hath been eſtabliſhed by the Royal Academy, and in the Obſervatory for the ſpace of 8 years, was confirmed by the emerſion of the firſt ſatellite obſerved at *Paris* 1676, *Nov.* 9th, 5 h. 35 min. 45 ſec. at night, 10 min. later than it was expected, by deducing it from thoſe that had been obſerved in the month of *Auguſt*, when the earth was much nearer to *Jupiter*.

Of Damps *in Mines; by Mr.* Rog. Moſlyn. Phil. Tranſ. N° 136. p. 895.

THE coal-work at *Moſlyn* in *Flintſhire* lies in a large parcel of wood-land, which hath a great fall directly north to the ſea-ſide; but the dipping or fall of the coal, partly croſſing the fall of the ground, is within a point of due eaſt, and lies 40, 50, 50, and ſometimes 60 yards under the level of the ſea: This work is upon a coal of five yards in thickneſs; when it was firſt found, it was very full of water, ſo that it could not be wrought down to the bottom of the coal; but a witchet, or cave, was driven out in the middle of it upon a level for gaining of room to work, and drawing down the ſpring of water that lies in the coal to the eye of the pit; and after they had gone a conſiderable way under ground in driving the witchet, and that they began to want wind, the fire-damps gradually formed themſelves, and appeared in the crevices and ſlits of the coal, where water had lain before the opening of the pit, with a ſmall blueiſh flame in continual motion; the applying of a candle to it would make it fly with a ſudden noiſe to another crevice, where it would appear blazing and moving as before: After long working of this coal, another roach of coal was found upon the riſing ground under the 5 foot coal at the depth of 14 yards, which proved to be 3 ½ yards thick, and ſomething more ſulphureous; as they ſunk the lower part of it, they had many appearances of the fire-damp in watry crevices, flaſhing and darting from one ſide to the other of the pit, and ſhewing rain-bow colours on the ſurface of the water in the bottom; but upon drawing up of the water with buckets, which moved the air in the pit, it would ceaſe burning, till the colliers at work with their breath and ſweat, and the ſmoke of their candles thickened the air in the pit, and then it would appear again; and ſometimes they lighted their candles in it when they went out, and ſo in this pit it did no further harm; but upon ſinking a pit within the hollows or deads on the upper work, at 16 or 17 yards diſtance from the firſt pit, after ſinking 6 or 7 yards, the fire-damp began to appear as formerly, accompanying the workmen ſtill as they ſunk; ſometimes they extinguiſhed it by blowing upon it, at other times with their candles; but as they ſunk down, and the damp got ſtill more and more ſtrength, they found that their want of perpendicular air from the day was the great cauſe and promoter of this damp; for the air that followed them down into this pit, came down at the firſt ſunk pit, at the above-mentioned diſtance, after it had been diſperſed over all the old hollows and deads of the former work, that were filled up with noiſome vapours, thick ſmothering fogs, and in ſome places with the ſmothering damp itſelf; notwithſtanding, they continued ſinking to 15 yards, plying the work night and day; but upon intermitting the work for 48 hours, and the damp gaining great ſtrength in the mean time, it would be ſeen flaſhing and ſhooting from one ſide to the other; upon which they would take a pole, and bind ſeveral candles to its extremity, which they no ſooner ſet over the eye of the pit, but the damp would fly up with a long ſharp flame, and put out the candles, leaving a foul ſmoke each time behind it; finding that theſe things had no effect, they adventured to bind ſome candles at a hook, hanging at a rope's end; upon lowering theſe a little way into the ſhaft of the pit, the damp would mount up, blow out the candles, diſperſe itſelf about the eye of the pit, and burn the hair, beards, and clothes of the workmen, and ſometimes ſtrike them down, making a noiſe like the bellowing of a bull, but much louder, and leaving a ſmoke and very noiſome ſmell behind it; at another time, one of the men more indiſcreet than the reſt, went headlong with his candle over the eye of the damp-pit, at which the damp immediately catched, and flew to and fro over all the hollows of the work, with a great wind, a continual fire, and a great roaring noiſe; the men at the firſt appearance of it, had moſt of them fallen on their faces, and hid themſelves as well as they could in the looſe fleck or ſmall coal, and under the ſhelter of poſts; yet the damp returning out of the hollows, and drawing towards the eye of the pit, came up with incredible force; the wind and fire tore moſt of their clothes off their backs, and ſinged what was left, burning their hair, faces, and hands; and the blaſt fell ſo ſharp upon their ſkin, as if they had been whipp'd with cords; ſome that had leaſt ſhelter, were carried 15 or 16 yards from their firſt ſtation, and beaten againſt the roof of the coal, and ſides of the poſts; and they lay afterwards a good while ſenſeleſs, ſo that it was a long time before they could hear or find each other; as it drew up to the day-pit, it caught one of the men along with it, that was next the eye, and aſcended with a dreadful crack, not unlike a cannon, but ſhriller, which was heard 15 miles off with the wind; and ſuch a pillar of ſmoke was ſeen, as darkened all the ſky for a great while; the brow of the hill above the pit was 18 yards high, and on it grew trees 14 or 15 yards long; yet the man's body and other things from the pit, were ſeen above the top of the higheſt trees, at leaſt 100 yards: On this pit ſtood a horſe-engine, of ſubſtantial timber and ſtrong iron-work, on which lay a trunk or barrel, for winding the rope up and down, of above 1000 pound weight; it was then in motion, one bucket going down, and the other coming up full of water; this trunk was faſtened to that frame with locks and bolts of iron; yet it was thrown up, and carried a good way from the pit; and pieces of it, tho' bound with iron-hoops and ſtrong nails, were blown into the neighbouring woods; as alſo the two buckets, and the ends of the ropes, after the buckets were blown from them, ſtood a while bolt upright in the air like pikes, and then came leiſurely down; the whole frame of the engine was moved out of its place; and the clothes, hats, caps of ſuch as eſcaped, were afterwards found torn to pieces, and thrown into the woods a great way from the pit; this happened in the beginning of *February*, a ſeaſon when other damps are ſcarce felt or heard.

Of the Diamond Mines; *by the Earl Marſhal of* England. Phil. Tranſ. N° 136. p. 907.

THE parts of the world wherein diamonds are found, are the iſland *Borneo*, and the continent of *India extra* and *intra Gangum*; *Pegu* is reported to have ſeveral mines, but the king of that country contents himſelf with his mines of rubies, ſapphires, topazes, emeralds, gold, ſilver, braſs, tin, and lead: The diamond mines of *Coromandel* are generally near rocky hills or mountains, a great ridge of which hills begins near cape *Comorin*, extends in breadth about 50 *Engliſh* miles, and runs thence in length quite thro' *Bengala*: The kingdoms of *Golconda* and *Viſapore* have mines abounding in diamonds; but their kings permit only to dig in ſome places, leaſt they ſhould become too common: *Colure* was the firſt mine uſed in *Golconda*; the earth is ſomewhat yellowiſh, not unlike the colour of dried gravel; but moiſter in ſome places, where it abounds in ſmooth pebbles, much reſembling thoſe of ſome gravel-pits in *England*; they uſe to find great numbers in the vein, improperly ſo call'd, the diamonds not lying in continued cluſters, as ſome imagine, but often ſcattering, ſo that ¼ of an acre may be dug, and nothing be found, eſpecially in mines that afford large ſtone near the ſurface of the earth, and about three fathoms deep; the diamonds found in theſe mines are generally well ſhaped, many of them pointed, and of a good lively white water; it alſo produces ſome yellow ones, ſome brown, and others of other colours; they are of ordinary ſizes, from about ſix in a mangelin to five or ſix mangelins each; a mangelin is four grains in weight, thoſe of 10, 15, 20, they find but rarely; they have frequently a bright and tranſparent coat, inclining to a green, tho' the heart of the ſtone be pure white; but the veins of theſe mines are almoſt worn out.

The mines of *Codawillikul*, *Malabar*, and *Buttepallem*, conſiſt of a reddiſh earth, inclining to an orange, with which it ſtains the clothes of the labourers that work therein, they dig about four fathoms deep; they afford ſtones generally of an excellent water and cryſtalline coat; and are of ſmaller ſizes than thoſe of *Colure*, *Ramiah*, *Gurem*, and *Muttompelle*, and have a yellowiſh earth like *Colure*; their ſtones are like thoſe of the two former mines, but mixt with others of a blue water: In *Currure*, the moſt ancient and famous of all, there have been found diamonds of a *Seize* weight, which is about 9 ounces *Troy*, or 81. ½ *Pago*'s weight; it is only employed by the king for his own private uſe; the diamonds found in it are very well ſpread, and large ſtones; it yields few or none ſmall; they have generally a bright coat, inclining to a pale green, but within they are pure white; the ſoil is reddiſh: Not far from *Currure* are the mines of *Lattawar* and *Ganjeconta*, in the ſame ſoil as *Currure*, and they afford ſtones not unlike them; but *Lattawar* yields many reſembling the end of a razor-blade, thin on one ſide, and thick on the other, very white, and of an excellent water; but the beſt of the mine is worn out, and *Ganjeconta* is employed only for the king's private uſe: *Jonagerre*, *Pirai*, *Dugulle*, *Purwillee*, and *Anuntapelle*, conſiſt alſo of red earth, and afford many large ſtones, part of them of a greeniſh water; but the moſt complete mines are thoſe of *Wazzergerre* and *Munnemurg*, the others reſembling pits rather than mines, for there they ſink thro' high rocks in ſome places 40 or 50 fathoms deep; the ſurface of the rocks conſiſt of hard, firm, white ſtone, into which they cut a pit like a well, of about four or five, in ſome places ſix foot deep, before they come to the cruſt of a mineral ſtone, like the mineral of iron; then they fill the hole with wood, and keep as hot a fire as they can there for two or three days, till they think it ſufficiently heated; then they pour in water till they have quenched it, which mollifies both ſtone and mineral; when both are cold, they dig again, take out all the crumbled ſtuff, and dig up what they can, before they heat it a-new: The cruſt is ſeldom thicker than three or four foot, after which they come to a vein of earth, that uſually runs under the rock two or three furlongs, ſometimes much farther; and they dig as deep as they can, till they come to water, and then they can go no deeper, becauſe they want thoſe engines which are known in *Europe*; all the lumps of the mineral they break in pieces, and frequently they find diamonds encloſed in them; the earth is red, and many large ſtones are found in it, the ſmalleſt about ſix in a *Mangelin*; they are of mixed waters, but the greateſt part good, only they are of diſagreeable ſhapes; there are many craggy pieces of ſtone, ſome appear as if they had been parts of very large ones; others have pieces broken off: In

Langumboot they dig in the ſame manner as at *Wazzergerre* and *Munnemurg*, the rock is not altogether ſo ſolid, but the earth and ſtones it produces much like them: *Wootoor* lies near *Currure*, and affords ſtones of a like magnitude, ſhape and water; it is employed only for the king's uſe; and it has this peculiar that its diamonds are found in black earth. *Muddemurg* far exceeds all the reſt for diamonds of a delicate ſhape, water, and bright tranſparent coat; yet it has ſtore of veiny ones, but theſe are alſo of ſuch various ſhapes and water, that it is difficult to diſtinguiſh them from the good, eſpecially the ſmall ones; it produces ſtones of divers magnitudes, from 10 and 12 in a *Mangelin* to 6 or 7 *Mangelins* each, ſome wherefore are very large; the earth is red, but among woods, and the water ſo bad, that it preſently cauſes fevers in ſtrangers, inſomuch that it is forſaken; yet it would have been more profitable than any of the reſt, the vein frequently lying near the ſurface, ſeldom running deep, and richer than any yet diſcovered; *Kiſhma* a river of excellent waters is but nine miles diſtant, but the miners or merchants will not be at the charge of fetching their water from thence; it is the opinion of many that beſides the water, the town lying in a bottom, environed with hills, and a moraſs adjoining, the air may be infected, and contribute to its unwholeſomneſs: The earth of *Melwillee*, or the new mine, is very red; the ſtones found there are generally well ſhaped, their ſize is from five or ſix in a *Mangelin* to thoſe of 14 or 15 each, and ſome bigger; but the greateſt numbers are of a middling ſize; moſt of them have a thick dull coat, inclining to a yellowiſh water, not altogether ſo ſtrong and lively as thoſe of the other mines, and very few of them are of a cryſtalline water and coat; they are ſaid to be apt to flaw in ſplitting; many of them that promiſe by their ſeeming whiteneſs when rough, diſcover their deceitfulneſs, after paſſing the mill, and too often betray a yellowiſh tincture: In *Ramulconeta*-mines, in a red earth about 15 or 16 foot deep, they ſeldom find a diamond of a *Mangelin* weight, but ſmall ones to 20 or 30 in a *Mangelin*; they are generally of an excellent cryſtalline water, have a bright, clear, coat, inclining frequently to a pale green, they are well ſhaped, but few of them are pointed; there are alſo found amongſt them broken pieces of diamonds, by the country people called *Shemboes*: The mines at *Banugunnapelle*, *Pendekul* and *Moodawarum*, at *Cummerville*, *Paulkul* and *Workul*, which are not at a great diſtance from *Ramulconeta*, afford ſtones much alike, and in the ſame kind of earth; but in the three laſt are very ſmall ones, even to 100 in a *Mangelin*: *Langepoleur* mines are of a yellowiſh earth, like thoſe of *Colure*; its diamonds are generally well ſhaped, globular, pointed, of a good chryſtalline water and bright coats, but few in number; many of them have a thick dark graſs-green coat, ſome are alſo ſpotted with black, but within are pure white and clean; their ſizes are from two or three *Mangelins*, but few very ſmall: *Pootloor*-mines are of a reddiſh earth, yielding ſtones much like thoſe of *Lungepoleur*, only ſmaller; under a *Mangelin*, the general ſizes are of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, of a *Mangelin*: *Punchelingul*, *Shingarrampent*, and *Tondarpaar* are alſo of red earth, their diamonds are not unlike thoſe of *Colure*, only rarely or never do they find any large ones there: *Gundepelle* hath the ſame earth with the former, and produces ſtones of equal magnitude, but frequently of a pure cryſtalline water, wherein they exceed the former: *Donee* and *Gazerpelle* are both red earth and afford ſtones alike, and generally they are of good ſhape, and water; they have alſo many *Shemboes*, and ſome of a bad colour, and ſome brown; which they call ſoft or weak-watered, being eſteemed of a ſofter and weaker body than others, becauſe they have not ſo much beauty when cut, and that they are ſubject to flaw in cutting upon the mill; their general product are ſtones of a middle ſize; but *Gazerpelle* has beſides many large ones, and is the only noted mine in the kingdom of *Viſapore*.

The diamonds in all the mines are ſo ſcattered in the earth, and lie ſo thin, that in the moſt plentiful mines it is rare to find one in digging, and not before they have cleared them of the cloddy matter, in which they are frequently incloſed, and ſome of thoſe of *Melwillee* have the earth ſo fixed about them, that, before they are ground on a rough ſtone with ſand, their tranſparency cannot be diſcovered: Near the place where they dig they make a ciſtern about two foot high and ſix foot over, with a ſmall vent in one of the ſides, about two inches from the bottom, by which it empties itſelf into a little pit made in the earth to receive ſmall ſtones, if any ſhould happen to fall thro'; the vent being ſtopped, the ciſtern is filled with water, ſoaking therein as much of the earth dug out of the mines, as it can conveniently receive at a time, then they break the clods, pick out the largeſt ſtones, and ſtir it with ſhovels till the water is all muddy, the gravelly matter falling to the bottom; after which they open the vent, letting out the foul water, and ſupplying it with clean, till all the earthy ſubſtance be waſhed away, and nothing but gravel remain at the bottom; thus they continue waſhing till about 10 o'clock in the forenoon, when they take the gravelly ſtuff they have waſhed, and ſpread it on a plain and ſmooth place like a bowling-green near the ciſtern, which when dried by the heat of the ſun, they carefully ſearch it, that the ſmalleſt bit of a ſtone can ſcarce eſcape them; if they find a large ſtone, they deliver it privately, leaſt it ſhould come to the knowledge of the governour of the place, and he require a ſhare, which in the kingdom of *Golconda* is uſually practiſed: The merchants who buy thoſe ſtones are the *Banians* of *Guzzarat*, who, for ſome generations have forſaken their own country to take up the trade, with which they have had ſuch ſucceſs, that they have wholly engroſſed it; and correſponding with their country-men in *Surat*, *Goa*, *Golconda*, *Viſapore*, *Agra*, *Dillee* and other parts of *India* they furniſh them with diamonds. In *Golconda*, all the ſtones under a *Pagoda* weight, which is nine *Mangelins*, are to be the adventurers, but all of that weight and above it to be for the king's uſe; both merchant and miner go generally naked, with only a poor rag about their middle, and a ſaſh on their heads; they dare not wear a coat, leſt the governour ſay they have thriven much, are rich, and ſo enlarge his demands on them: When they find a great ſtone, they conceal it till they have an opportunity of retiring with wife and children into *Viſapore*, where they are ſafe and well uſed; on which account their mines are much more populous, and better employed than thoſe of *Golconda*; tho' all ſtones above a certain weight muſt be for the king's uſe, yet in the metropolis of either kingdom, as the cities of *Golconda* and *Viſapore*, there is no ſeiſure, all ſtones being free.

The Manner of Hatching Chickens *at* Cairo; *by Mr.* J. Greaves. Phil. Tranſ. N° 137. p. 923.

THERE is a long entrance *ab* Fig. 1. Plate IV. in the houſes built for hatching the eggs, on each ſide of which are fourteen ovens, ſome places have more, and ſome fewer; the bottoms and ſides of theſe ovens, which are on the ground, are all made of ſun-dried bricks; upon which they put mats, and on the mats, the eggs: The top of theſe ovens are flat, and covered with ſticks, except two long ſpaces which are made of ſun-dried bricks; and they are the hearths on which the fires are made, to heat the eggs that lie under them in the lower ovens: Above theſe lower ovens are ſo many others, made of ſun-dried bricks, and arched a-top; where alſo are ſome holes, which are ſtopped with tow, &c. or left open, at pleaſure, to regulate the heat in the ovens below: The upper ovens are made in this manner; *a*

Fig. 2. is the mouth of the oven, opening into the long entrance above-mentioned; *b* and *c* are entrances into the adjoining ovens; *d*, *e* are two hearths three or four inches deep, in which they make the fire, to heat this and the oven below; the depth of the lower oven is about two feet and a half *Engliſh*, the ſecond above four.

They begin to heat their ovens in the middle of *January*, burning every morning an hundred kintars, or an hundred pound weight of camels or buffalo's dung, and the like proportion at night, till the middle of *February*; about which time the ovens are ſo hot, that one cannot well endure to lay his hand upon the walls: After this they put the eggs into the ovens to hatch the chickens, which they continue to do ſucceſſively till the end of *May*.

The eggs are firſt put upon mats in the lower ovens, which are upon the ground, ſeven or eight thouſand in number, and laid only double one upon the other: In the ovens above the lower, the fire is made in long hearths, or little channels, from whence the heat is conveyed into the lower ovens before-mentioned; the eggs which are directly under theſe hearths, lie triple one on the other; the reſt, as was ſaid, only double: At night when they renew the fires in the hearths above-mentioned; they then remove the eggs that were directly undermoſt, and which lay triple one upon the other, into the place of thoſe which lay on the ſides only double; and theſe being now removed, they lay them triple under the hearth, becauſe the heat is greater there than on the ſides where the eggs are only double: Theſe eggs continue in the lower ovens fourteen days and nights; afterwards they remove them into the upper ovens, which are juſt over the lower; in theſe, there being now no more fire uſed, they turn all the eggs four times every twenty four hours: The 21ſt or 22d day the chickens are hatched, the firſt day they eat nothing, the ſecond day they are fetched away by women, who give them corn, &c. The maſter of the ovens hath a third of the eggs for his pains; out of which he is to make good to the owners, if any happened to be ſpoiled or miſcarry, ſo that they muſt always have two thirds in chickens for their eggs: The fire in the upper ovens, when the eggs are placed in the lower, is thus proportioned: The firſt day, the greateſt fire; the ſecond, leſs than the firſt day; the third day leſs; the fourth day more than the third; the fifth day leſs; the ſixth day more than the fifth; the ſeventh day leſs; the eighth day more; the ninth day without fire; the tenth day a little fire in the morning; the eleventh day they cloſe all the holes with flax, *&c.* making no more fire; for if they ſhould the eggs would break: They take care that the eggs be no hotter than what the eye of a man can endure: When the chickens are hatched they put them into the lower ovens, which are covered with mats; under the mats there is bran to dry the chickens; and on the mats ſtraw for them to ſtand upon.

The Barnacle; *by Sir* Rob. Moray. Phil. Tranſ. N° 137. p. 925.

IN the weſtern iſles of *Scotland*, much of the timber, wherewith the common people build their houſes, is ſuch as the weſtern ocean throws upon their ſhores; the moſt common are firs and aſh, they are uſually very large and without branches; which ſeem rather to have been broken or worn off, than cut; and they are ſo weather-beaten, that there is no bark left upon them, eſpecially the firs: In the iſland of *Uiſt* Sir *Robert* obſerved on the ſhore a large fir-tree of about two foot and a half diameter, and nine or ten foot long, which had lain ſo long out of the water, that it was very dry, and moſt of the ſhells that had formerly covered it were worn or rubbed off; only on the parts next the ground, there ſtill hung innumerable ſmall ſhells, of the colour and conſiſtence of muſcle-ſhells, containing within them ſmall birds perfectly formed, and ſuppoſed to be *Barnacles*, and their ſides were joined together with ſuch another film as muſcle-ſhells are, which ſerves them for a hinge to move upon, when they open and ſhut: The figure of the *Barnacle*-ſhell is repreſented Fig. 3. Plate IV. it is thin about the edges, and about half as thick as broad; each of the ſhells hath ſome croſs ſeams or ſutures, which divide it into five parts, which are faſtened to each other with ſuch a film as muſcle-ſhells are: Theſe ſhells hang at the tree by a neck longer than the ſhell, of a kind of a filmy ſubſtance, round, and hollow, and creaſed, not unlike the wind-pipe of a chicken, ſpreading out broadeſt, where it is faſtened to the tree; from which it ſeems to draw the matter, which ſerves for the growth and vegetation of the ſhell, and the little animal within it. In every ſhell that he opened, he found a perfect ſea-fowl; the little bill like that of a gooſe; the eyes marked; the head, neck, breaſt, wings, tail and feet like thoſe of water-fowl; the feathers every where perfectly formed, and of a blackiſh colour, and the feet alike; the biggeſt he found upon the tree was about the ſize of the figure; he never ſaw any of the little birds alive, neither did he meet with any that did; only ſome credible perſons aſſured him they had ſeen ſome as big as their fiſt.

A Deſcription of Hirta; *by Sir* Rob. Moray. Phil. Tranſ. N° 137. p. 927.

Hirta lies from *Snod* in the iſle of *Skye* weſt and by north; and from the neareſt land to it in the *Harries*, from whence people ordinarily take boat, it lies due weſt, and at the diſtance of 50 miles: There are three adjoining iſlands, *viz. Hirta*, *Soa* and *Burra*; but *Hirta* is the only one inhabited; the other two afford excellent paſture for ſheep; and every ſheep there has two lambs a year: *Burra* is inacceſſible except to the men of *Hirta* alone, in regard of the difficulty of landing, there being but about a foot broad of a landing-place, and that only to be attempted when the boat riſes; for their ordinary way is, when they come near the rock, to turn the boat and ſet the ſide to ſhore, while two men, one at each end of the boat, with two long poles keeps it off, to prevent its daſhing violently againſt the rock, when it riſes; at which time only, he that is to land, makes his attempt; if he miſs his landing place, he falls into the ſea, and his fellows hale him a board by a ſmall rope faſtened about his middle to prevent that danger; but when he ſafely lands, which he ſeldom fails to do, the others land one by one, except ſo many as are to attend the little boat, which is ordinarily of ſix oars: If there be any ſtrangers, they muſt be tied about the middle with a ſtrong rope, and when the men of *Hirta* have climbed up to the top of the rock, which is above 24 fathoms, they hale up the ſtrangers by ropes; when they have gathered as many eggs and killed as many fowl as will load their boat, they lower all into it, and the ableſt fellow is always left behind; who, having none to help him, muſt throw himſelf into the ſea, and ſo recover the boat: *Burra* lies from *Hirta* about ſix miles to the north: *Soa* lies near *Hirta* on the ſouth-weſt; all that is remarkable in this iſland, beſides fowl, is a creek where great ſeals haunt: There are ſeveral rocks riſing out of the ſea among theſe iſlands, which the people of *Hirta* call *Stacka*, ſome 10, 20, and 24 fathoms above water, without any graſs upon them: On the round tops of the rocks a great number of fowls breed, as alſo in the cliffs; amongſt the reſt, there is one called *Stacka Donna*, on whoſe top a great number of fowls do breed, and tho' it ſeem inacceſſible, yet the men of *Hirta* have ventured thither: After landing with much difficulty, a man having room but for one of his feet, he muſt climb up 12 or 16 fathoms high; then he comes to a place, where having but room for his left foot and left hand, he muſt leap from thence to ſuch another place before him, which if he hit right the reſt of the aſcent is eaſy; and with a ſmall cord, which he carries with him, he hales up a rope, whereby all the reſt aſcend; but if he miſſes that ſtep as it is often the caſe, he falls into the ſea, his companions take him up by the ſmall cord, and then after ſome reſpite he tries it again.

Hirta is two miles in length accounted five-penny land; in it are ten families; the men ſeldom grew old, and ſeldom was it ever known that any man died in his bed there, but was either drowned or broke his neck; the men are ſtrong, big and well complexion'd; their food is only young fowl and eggs, their drink, whey and water; they are much given to keeping of holy-days; having a number of little chapels, where ſometimes they watch whole nights, making merry together at their offerings. The greateſt employment of their women is to harrow their land, which they muſt do, when their husbands are abroad climbing for fowl: Their ordinary way of dividing their land, is one half-penny to every family; and they alſo divide the rocks; and there is a kind of officer left by the maſter of the iſland, who governs in his abſence, and ſo orders it, that the beſt and worſt climbers are mixed together, that ſo none of the land be unemployed; that is, that the ſhelves of the higheſt rocks be ſearched for eggs: Their manner of climbing is this; they go two and two with a long rope made of thongs of ſalted cow-hide and plaited ſix or nine fold; each end of the rope is tied about each of their waſtes, and he that is foremoſt goes till he come to a ſafe ſtanding, the other ſtanding firm all the while to keep him up in caſe his foot ſhould ſlip; when the formoſt is come to a ſafe ſtanding, then the other goes either below or above him, as his buſineſs requires; and ſo they watch in their turn, and when they obſerve this, ſeldom any of them is loſt: When a couple is to be married, the above-mentioned officer carries them to one of their chapels and tenders them an oath, and thus they are married: Their children when 15 or 16 years old are brought by the maſter of the iſle to the *Harries*, and there baptized: An ordinary way of killing fowl in miſty weather is this; they lie flat on their backs, and open their breaſts; which when the fowl obſerve, they pearch upon them, and they are preſently taken; and thus hundreds are taken in one night: Sometimes they ſet gins on the very top of the higheſt rocks, which are made very ſtrong for large fowl.

Obſervations on a Cameleon; *by Dr.* Jonathan Goddard. Phil. Tranſ. N° 137. p. 930.

THIS *Cameleon* was a female, the ſkin was mixed of ſeveral colours like a medley cloth, lighter towards the belly, but round about it equally mixed; the colours diſcernable were a green, a ſandy yellow, and a deeper yellow tending to a liver-colour; but one might eaſily imagine on the ſkin a mixture of moſt or all colours, whereof ſome are more predominant at times than others; there are ſome permanent black ſpots on the ridge of the back, and on the head; upon excitation or warming, the animal becomes ſuddenly full of black ſpots of the bigneſs of a great pin's head, equally diſperſed on the ſides, with ſmall black ſtreaks on the eye-lids; all which do afterwards vaniſh; the ſkin is grained with globular inequalities, like ſhagreen; the biggeſt grains are about the head, the next on the ridge of the back, and the next on the legs, the fineſt are on the ſides and belly; which perhaps in ſeveral poſtures may ſhew ſeveral colours; and when the animal is in full vigour may have the effect of a mirrour, and reflect the colours of bodies adjacent; which together with the mixture of colours in the ſkin may have given occaſion to the old tradition of its changing into all colours; The eyes reſemble a lens or convex-glaſs ſet in a verſatile globular ſocket, which the animal turned this way and that without moving its head, and ordinarily, the one a contrary way to the other; the tongue was eaſily drawn out, when the animal was dead, to half the length of the body, being round and full towards the tip like a peſtle, where it was hollow, with a bone which reaches from its root half its length, over which the fore-part would ſlip backwards, and the bone at its connection was bifurcated; its teeth were plainly ſeen and felt both above and below on the whole circumference of the jaw: The trunk of the body, by its ſtructure, is all thorax or breaſt, with ribs from the neck to the beginning of the tail, and they are of two ſorts; the larger above tending backwards from the ſpine or back-bone; the others tending forwards from the extremities of the former, as in the breaſts of fowl; there is alſo a kind of a diaphragm, a thin tranſparent membrane, as in birds, ſeparating about a fourth part of the cavity from the reſt, wherein is contained a ſmall ſtomach connected with the gullet, and to which is continued an inteſtine with ſome ſmall convolutions, which, when extended, is about the length of the whole animal including both head and tail; the excrements were black, or of a dark *French* green; the liver was thin and ſmall, contiguous to the diaphragm, partly divided into lobes of a blackiſh dark colour; the lungs ſeemed to conſiſt of membranous cells or diviſions, very thin and tranſparent, reſembling a little light froth; the heart was firm and fleſhy, but very ſmall, and in the fore part of the breaſt; behind at the extremity of the body was a double ovary, conſiſting of five or ſix eggs on each ſide, of the bigneſs of the largeſt pin's head, and ſticking to the back, and of the colour and conſiſtence of the yolk of an egg.

The Iron-Works *in the Foreſt of* Dean; *by Mr.* Hen. Powle.

Phil. Tranſ. N° 137. p. 931.

THE foreſt of *Dean*, comprehending that part of *Glouceſterſhire*, that lies betwixt the rivers *Wye* and *Severn*, does generally conſiſt of a ſtiff clay; which is very deep and miry in winter, and in ſummer dry and parched; the country is full of hills, but no where high; between theſe hills run many ſmall ſprings, of a more browniſh colour than common water, and often leaving in their paſſage tinctures of ruſt; the ground is naturally inclined to wood, eſpecially hazel and oak, of which latter it formerly produced ſtately timber, tho' now almoſt quite deſtroyed by the increaſe of the iron-works; upon the ſurface of the earth in ſeveral places lie many rough ſtones, ſome of a vaſt bulk; but where they ſink their mines, they rather meet with veins of ſcaly ſtone, than hard and ſolid rocks; within the foreſt they find great plenty of coal and iron-ore, and in ſome places red and yellow oker: The iron-ore is found in great plenty in moſt parts of the foreſt, differing both in colour, weight, and goodneſs; the beſt, which they call bruſh-ore, is of a blueiſh colour, very ponderous and full of little ſhining ſpecks like grains of ſilver; this affords the greateſt quantity of iron, but melted alone produces a metal very ſhort and brittle, and therefore not ſo fit for common uſe; to remedy this inconveniency, they make uſe of cinder, which is nothing elſe but the refuſe of the ore, after the metal hath been extracted, and which mingled with the other in a due quantity, gives it that excellent temper of toughneſs, for which this iron is preferable to any brought from abroad; this cinder is found in great quantities over all the country, where any former works ſtood; for in former times, their bellows being only moved by the ſtrength of men, their fires were much leſs intenſe than in the furnaces they now employ; ſo that they melted down the principal part of the ore only, and rejected the reſt as uſeleſs.

After they have provided their ore, their firſt work is to calcine it, which is done in kilns much after the faſhion of ordinary lime-kilns; theſe they fill up to the top with coal and ore *Stratum ſuper Stratum*, or in layers, until it is full; and ſo putting fire to the bottom, they let it burn till the coal be waſted; this is done without fuſion of the metal, and ſerves to conſume the more droſſy parts of the ore, and to make it friable, and ſupplies the beating and waſhing uſed for other metals; from hence it is carried to their furnaces, which are built of brick or ſtone, about 24 foot ſquare on the outſide, and near 30 foot high, and within not above 8 or 10 foot over, where it is wideſt, which is about the middle; the top and bottom have a narrowed compaſs, and it reſembles much the ſhape of an egg: Behind the furnace are placed two huge pair of bellows, whoſe noſes meet at a little hole near the bottom; theſe are compreſſed together by certain buttons placed on the axis of a very large over-ſhot wheel; as ſoon as theſe buttons are ſlid off, the bellows are raiſed again by the counterpoiſe of weights, whereby they are made to play alternately, the one giving its blaſt while the other is riſing: The furnaces are at firſt filled with ore and cinder intermixt with fuel, which in theſe works is always of charcoal, laying them hollow at the bottom, that they may more eaſily take fire; but after they are once kindled, the materials run together into a hard cake or lump, which is ſuſtained by the ſhape of the furnace; and thro' this the metal, as it melts, trickles down into the receivers, where there is a paſſage open, by which they take away the ſcum and droſs, and let out the metal as they ſee occaſion: Before the mouth of the furnace lies a great bed of ſand, wherein they make furrows of what faſhion they pleaſe; into theſe, when their receivers are full, they let in their metal, which is made ſo very fluid by the violence of the fire, that it not only runs to a conſiderable diſtance, but continues boiling for a good while: After theſe furnaces are once at work, they keep them conſtantly employed for many months together, never ſuffering the fire to ſlacken night and day, but ſtill pouring in at the top new ſupplies of fuel and other materials: Several attempts have been made to introduce the uſe of ſea-coal into theſe works inſtead of charcoal, the former being to be had at an eaſier rate than the latter, but hitherto they have proved ineffectual; the workmen finding by experience, that a ſea-coal fire, how vehement ſoever, will not penetrate the moſt fixt parts of the ore, and ſo leaves much of the metal unmelted: From theſe furnaces they bring their *Sows* and *Pigs*, as they call them, to their forges, which are of two ſorts, tho' ſtanding under the ſame roof, one they call the *Finery*, the other the *Chafery*; both of them are open hearths, on which they place great heaps of ſea-coal, and behind them bellows, like thoſe of the furnaces, but nothing near ſo large; into the *Finery* they firſt put their *Pigs* of iron, placing three or four of them together behind the fire, with a little of one end thruſt into it; where ſoftening by degrees, they ſtir and work them with long bars of iron, till the metal runs together into a round maſs or lump, which they call a *Half-bloom*; this they take out, and giving it a few ſtrokes with their ſledges, they carry it to a great weighty hammer, raiſed likewiſe by the motion of a great water-wheel; where applying it dexterouſly to the blows, they preſently beat it out into a thick ſhort ſquare; this they put into the *Finery* again, and heating it red hot, they work it out under the ſame hammer, till it become of the ſhape of a bar in the middle, with two ſquare knobs at the ends; laſt of all they give it other heatings in the *Chafery*, and more workings under the hammer, till they have brought their iron into bars of ſeveral ſhapes and ſizes; and if they omit any one proceſs, it will be ſure to want ſome of its toughneſs, which they eſteem its perfection; tho' for ſeveral purpoſes, as for backs of chimneys, hearths of ovens, and the like, they have a ſort of caſt-iron, which they take out of the receivers of the furnace in great ladles, as ſoon as it is melted, and which they pour into moulds of fine ſand; but this ſort of iron is ſo very brittle, that being heated, with one blow of a hammer it breaks all to pieces.

The Way of making Ceruſs; *by Sir* Philiberto Vernati. Phil. Tranſ. N° 137. p. 935.

PIGS of clean and ſoft lead are caſt into thin plates a yard long, and ſix inches broad, and as thick as the back of a knife; theſe are rolled round in ſuch a manner as that the ſurfaces no where touch, for where they do, no ceruſs grows; each of theſe is put into a pot juſt capable of holding one, ſuſtained by a little bar from the bottom, that it come not to touch the vinegar, which is put into each pot to effect the converſion; twenty of theſe a-breaſt are put into a ſquare bed of new horſe-dung, ſo as to make up the number of 400 to one bed; then each pot is covered with a plate of lead, and at laſt the whole is covered with boards as cloſe as poſſible; this repeated four times, makes what they call one heap, containing 1600 pots: After three weeks the pots are taken up, the plate unrolled, laid upon a board, and beaten with battledors till all the flakes come off; which, if good, prove thick, hard, and weighty; theſe flakes are ground with water between mill-ſtones to almoſt an impalpable powder; after which it is moulded into ſmaller parcels, and expoſed to the ſun to dry, till it be hard, and ſo fit for uſe: It is obſerved, that ſome pots will yield thick and good flakes, whilſt others alike ordered, and ſet by them without any poſſible diſtinction of advantage, yield few and ſmall flakes, or none at all; ſometimes are taken up all dry, and thus ſometimes prove beſt; again, they are ſometimes taken up wet: The plates that cover the pots yield better and thicker flakes than the rolls within; and the outſides, next the planks, larger and better flakes than the inſides next to the rolls, and the ſpirits that firſt ariſe from the vinegar: The accidents that befal the workmen, are immediate pain in the ſtomach, with exceſſive contortions in the guts, and coſtiveneſs that yields not to cathartics, and hardly to often repeated clyſters, but beſt to lenitives, oil of olives or ſtrong new wort; they alſo fall into acute fevers, and aſthma's, or ſhortneſs of breath; and theſe are chiefly effected by the mineral ſteams in caſting the plates of lead, and by the duſt of the flakes, as alſo by the ſteams proceeding from the heaps, when the pots are taking up; then a vertigo, or dizzineſs in the head, with continual exceſſive pain in the brows, blindneſs, ſtupidity, and paralytic affections, loſs of appetite, ſickneſs, and frequent vomitings, generally of pure phlegm, ſometimes mixed with choler to the extreme weakning of the body.

The Culture of Saffron; *by Mr.* Ch. Howard. Phil. Tranſ. N° 138. p. 945.

SAffron-heads planted in a black rich ſandy mold, or in a mixt ſandy land between white and red, yield the greateſt plenty of ſaffron; a clay or ſtiff-ground, be it ever ſo rich, produces little ſaffron, tho' plenty of heads and roots, if the winter prove mild and dry; but the extremity of cold and moiſture will rot them, ſo that the fineſt light ſandy mold, of an indifferent fatneſs, is eſteemed moſt profitable: Plough the ground in the beginning of *April*, and lay it very ſmooth and level; about three weeks or a month after, ſpread upon every acre twenty loads of rotten dung, and plough it in: At *Midſummer* plough it again, and plant the ſaffron-heads in rows, every way three inches diſtant from each other, and three inches deep: The moſt expeditious way of planting, is to make a trench the whole length of the field, three inches deep with a ſpit-ſhovel, which is to be made of a thin ſtraight iron ten inches long, five inches broad, with a ſocket in the ſide of it to put a ſtaff or handle; lay the ſaffron-heads at three inches diſtance in the trench, and with the ſhovel ſpit up three inches of earth upon them: Obſerve this order in planting of whole fields, whereby the heads will lie every way three inches from each other; only paths or ſhallow trenches are to be left two or three yards aſunder, which ſerve every year to lay the weeds to rot, that are to be weeded and pared off the ground: As ſoon as the heads begin to ſhoot or ſpear within the ground, which is uſually a fortnight before *Michaelmas*, hoe or pare the ground all over very thin, and rake lightly all the weeds and graſs very clean, leſt they choke the flowers, which will ſoon after appear; and are then to be gathered, and the ſaffron to be picked and dried for uſe: The ground muſt be very carefully fenced from ſheep or cattle, which tread down the ſaffron-graſs, and make the chives come up ſmall: In *May* the ſaffron-graſs will be quite withered away, after which the weeds and graſs may be cut or mowed off from time to time to feed cattle till about *Michaelmas*, at which time the heads will begin to ſpear within the ground; then hoe, pare, and rake the ground clean as before, for a ſecond crop; and the like directions are to be obſerved next year for a third crop: The *Midſummer* following dig up all the ſaffron-heads, and plant them again in another ground, dunged and ordered as above, wherein no ſaffron hath been planted, at leaſt not for ſeven years: The flowers are to be gathered as ſoon as they come up, before they are full blown, whether wet or dry: Pick out the chives clean from the ſhells or flowers, and ſprinkle them two or three fingers thick very equally on a double ſaffron paper; lay this on the hair-cloth of the ſaffron-kiln, and cover it with two or more ſaffron-papers, a piece of woolen cloth, or thick bays, and a cuſhion of canvaſs or ſack-cloth filled with barley-ſtraw, whereon lay the kiln-board: Put into the kiln, thoroughly kindled, charcoal, embers or the like, keeping it ſo hot that you can hardly hold your fingers between the paper and the hair-cloth; in an hour or more turn in the edges of the cake with a knife, and looſen it from the paper; if it ſtick faſt, wet the outſide of the paper with a feather dipped in beer, and then dry the papers; turn the cake that both ſides may be of a colour: If it ſtick again to the paper, looſen it, and then dry it with a very gentle heat, with the addition of a quarter of a hundred weight laid upon the kiln-board: The ſaffron-cake, being ſufficiently dried, is fit for uſe, and will laſt a good many years, if wrapt up and kept cloſe: The beſt ſaffron is that which conſiſts of the thickeſt and ſhorteſt chives, and of a high red and ſhining colour, both within and without: Saffron is often burnt, and in knots, ſpotted and mixed with the yellows that are within the ſhells: It is uſually obſerved, that an acre doth yield at leaſt 12 pounds of good ſaffron one year with another, and ſome years 20 pounds: Good ſaffron is ſeldom or never ſold at ſo low a rate as 30 ſhillings a pound, but frequently at 3 pounds and upwards a pound; wherefore one acre bearing 12 pounds at 40 ſhillings a pound comes to 24 pounds a year: The gathering and picking of 1 pound of ſaffron is worth a ſhilling, which comes to 12 ſhillings an acre: Fire and drying may come to 3 ſhillings more, at 6 pence the pound; which in all makes 15 ſhillings: The graſs that is mowed, and cut off the ground for the uſe of cattle, will be very near worth as much as will countervail the picking and drying the ſaffron; the ſoil being enriched not only by the dung, but the ſaffron itſelf; as appears by the rich crops the ground yields for ſeveral years after, without any other manuring or improvement: 16 quarters of ſaffron-heads are ſufficient to plant 1 acre; a quarter of theſe heads is uſually ſold at the place for 10 ſhillings, which comes to 8 pounds *per* acre: 20 loads of rotten dung laid on the ground, may be worth 40 ſhillings, at 12 pence a load for the dung, and as much for carriage into the field: For thrice plowing the ground 20 ſhillings: For planting the heads, about 4 pounds; which in the whole makes 14 pounds, the charges of planting an acre, which will bear 3 crops: So that all things reaſonably computed, it appears that an acre of ſaffron will be worth, notwithſtanding all caſualties, 1 year with another, over and above the 14 pounds charges, for the firſt year's planting, at leaſt 20 pounds *per Annum*; beſides the great increaſe of the ſaffron-heads which will be 3 for 1: The kiln conſiſts of an oaken frame, lathed on every ſide; 12 inches ſquare in the bottom, 2 foot high, and 2 foot ſquare at top; on which is nailed a hair-cloth, and ſtrained hard by wedges drove into the ſides; a ſquare board, and a weight to preſs it down, weighing about a quarter of a hundred: The inſides of the kiln are covered all over, above 2 inches thick, with the ſtrongeſt potter's clay, very well wrought with a little ſand: The bottom muſt be lined with clay 4 or 5 inches thick, which is the hearth to lay the fire on; level therewith a little hole is to be made to pile the fire; the outſide may be plaiſtered all over with lime and hair.

Of Tin-Mines; *by Dr.* Chr. Merret. Phil. Tranſ. N° 138. p. 949.

THE ſtone, from which tin is wrought, is moſt uſually found between two walls of rocks, which are generally of an iron colour, of little or no affinity with the tin, in a vein of lead, as the miners call it, between 2 and 18 inches broad, or thereabouts: Sometimes there is a rich and fat metal, ſometimes hungry and ſtarved; ſometimes nothing but a droſſy ſubſtance, not purely earth, ſtone, or metal, but a little reſembling the rejected cinders of a ſmith's forge, appearing ſometimes of a more flouriſhing colour, tending to a carnation, and ſometimes more duſky; and where this is found, the miners judge the metal to be ripe; the pits are ſometimes above 60 fathoms deep, the load very rich and good; above that is about 10 fathoms from the graſs; and below that, a ſtrange cavity, or empty place, wherein is nothing but air for many fathoms deep, as the miners have tried with long poles and pikes; this cavity lies between hard ſtony walls, diſtant from each other about 6 or 9 inches; the labourers tell odd ſtories of ſprights of ſmall people, as they call them; and that, when the damp ariſes from the ſubterraneous vaults, they hear ſtrange noiſes, horrid knockings, and fearful hammerings; theſe damps render many lame, and kill others outright, without any viſible hurt upon them: Tho' tin, for the moſt part, is made from the ſtones, in which it is incorporated, yet ſometimes it is, as it were, mixed with a ſmall gravelly earth, which is ſometimes white, but for the moſt part red; from this earth it is eaſily ſeparated with bare waſhing; this gravelly tin is called *Pryan Tin*; and is ſcarce of half the goodneſs of the other: The *Mundick* ore is eaſily diſcovered by its glittering, yet ſad brown colour wherewith it ſtains the fingers; this is ſaid to nouriſh the tin; and yet they think, where much *Mundic* is found, there is little or no tin; certain it is, if there be any *Mundic* left in melting the tin, it makes it thick and cruddy; that is, not ſo ductile; and therefore uſually draws down the metal to an abatement, from 5 to 8 ſhillings in the hundred weight; this *Mundic* ſeems to be a kind of ſulphur, fire only ſeparating it from the tin and evaporating it into ſmoke; and this ſmoke gathers upon little ſprigs or boughs ſet in the chimney into a ſubſtance called

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Poiſon, and thought to be a kind of arſenic, which put into water eaſily diſſolves, and produces very good vitriol; the water in which it is diſſolved, ſoon changes ſmall iron-rods put into it; and in a little time it is ſaid to aſſimilate them into its own nature; it is generally concluded, that fiſh will die in thoſe waters into which *Mundic* is caſt, and they commonly impute the death of ſome of their neighbours to the drinking of *Mundic* waters; when they burn it, to ſeparate it from the tin, it yields a very loathſome and dangerous ſtench: There alſo occurs a ſort of ſpar of a ſhining whitiſh ſubſtance, which caſts a white froth upon the water in waſhing it; when firſt taken out of the earth, it is ſoft and fattiſh, but ſoon after it grows ſomewhat hard; it is ſeldom found growing, but only ſticking to the metal; the miners call it white ſpar; and ſome of them think it is the mother or nouriſher of the metal; but it is certain that ſpar is often met with in mooriſh grounds, where they never expect to find any ore; yet no tin-mines are without it.

The *Corniſh* diamonds lie intermixed with the ore, and ſometimes on heaps; they are hard enough to cut glaſs, and ſome of them are of a tranſparent red, and have the luſtre of a deep ruby; they ſeem to be only a finer, purer, and harder ſort of ſpar.

Godolphin ball or mine is the moſt famous in all *Cornwal* for the quantity of metal; tho' ſome pretend another mine called the ſilver- or lead-mine more rich than that; and Dr. *Merret* ſaw an aſſay made of ſome of that ore, and 10 pound weight yielded 2 $\frac{1}{4}$ ounces of fine ſilver.

The beſt ore is that which is in ſparks; and the next, that with bright ſpar in it: When the ore hath paſſed the ſtamping-mill, and is well waſhed and ſeparated from the parts not metalline, which they call the *Cauſalty*, they dry it on a furnace on iron-plates, and then grind it very fine in a crazing-mill; after this they re-waſh it, then dry it a little, and carry it laſt of all thus fitted to the furnace, called a blowing-houſe, and there melt and caſt it: There ſwims on the metal, when it runs out of the furnace, a ſcum which they call droſs, much like to ſlag or droſs of iron, which, melted down with freſh ore, runs into metal: The *Cauſalty* they throw in heaps upon banks, which in ſix or ſeven years they fetch over again; but they obſerve, that in leſs time it will not afford metal worth the pains, and afterwards none at all.

Expe-

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Experiments of refining Gold *with* Antimony; *by Dr.* Jonathan Goddard. Phil. Tranſ. N° 138. p. 953.

HAving taken 178 grains of crown gold of 22 carats fine or $\frac{11}{12}$, and the alloy partly ſilver, partly copper, and generally more of the latter; it was melted with two ounces and two drams of antimony, which is about ſix times the quantity of the gold; and becauſe the gold was made into plates, for the more certain melting and mixture, the firſt *Regulus* of gold being ſeparated from the antimony, both were powdered a-part, and the *Regulus* in the melting pot laid upon the ſame antimony, and ſo were both melted down again; in which meltings, ſuch a degree of heat was given, as made all of a clear light, red, burning heat; then the pot was taken out of the fire, and all permitted to ſeparate, ſettle and cool in it: Upon the breaking the pot, the gold being very diſtinct in the bottom, and eaſily ſeparated from the antimony, weighed 163 grains: This way of cooling all in the pots was obſerved in all the following experiments, for the more certain ſeparation and ſettling of the *Regulus*, without effuſion into the antimony-horn, or hollow iron-cone; which effuſion by confounding and cooling the mixture may be ſome hindrance to a more perfect ſeparation; and in the bottom of the cone there is always a thin cruſt of the crude antimony, not eaſily ſeparable without taking off ſome part of the *Regulus*; note alſo, that borax was uſed in every pot for preventing the ſticking of the *Regulus* to the bottom and the antimony to its ſides, ſo that both were gotten off clean and in full quantity: A piece was broken off the *Regulus*, which weighed 38 $\frac{1}{2}$ grains, and was kept to be refined upon the coppel apart; the weight of the remainder was 124 $\frac{1}{2}$ grains, which being powdered and put upon two $\frac{1}{4}$ ounces of freſh antimony and melted down, the *Regulus* weighed 74 grains: The other pieces of 38 $\frac{1}{2}$ grains being refined on a coppel from the antimonial ſubſtance mixed therewith by exhalation, promoted ſome time with a blaſt upon it, eſpecially toward the latter end, as in all the following experiments of refining on the coppel, 30 $\frac{1}{2}$ grains upon melting with borax in a crucible did not loſe above half a grain; ſo that the weight of the whole to the gold it held, was 38 $\frac{1}{2}$ to 30 $\frac{1}{2}$, or the gold almoſt $\frac{5}{6}$ of the whole; the latter *Regulus* weighing 74 grains, and refined in the ſame manner weighed 63 grains, the gold being in proportion to the whole as 63 to 74, that is, nearly $\frac{6}{7}$ of the whole; ſo that the ſame *Regu-*

Regulus of gold and antimony, in paſſing thro' new antimony, tho' it loſes in weight, yet it is richer in gold, and appears ſo to ſenſe, being of a redder complexion, more tough and harder to powder: Both the parcels of antimony were ſeverally mixed with equal quantities both of tartar and nitre, and then fired, and ſo reduced to a *Regulus*; then the *Regulus* of each exhaled and blown off upon coppels; of the firſt parcel of antimony wherewith the gold was firſt melted, the *Regulus* being exhaled, there remained in gold 36 grains, which upon melting in a crucible did ſcarce loſe half a grain: Of the ſecond parcel of antimony, with which the firſt *Regulus* of gold and antimony weighing $124\frac{1}{2}$ grains was melted, their remained in gold 27 grains: All the other parcels were upon the touch fine gold to ſenſe, only that of the firſt antimony was apparently not fine and pale from the ſilver mixed with it in the original alloy, as appeared by comparing it on the touch-ſtone with ſovereign gold allayed with ſilver, holding apparently about a fourth part of ſilver, as the ſovereign gold does a ſixth; neither was it altogether free from copper, becauſe upon nealing, it always turned black on the ſurface; but for the more exact diſcovery, it was taken and firſt refined with lead upon a copple, for ſeparating any copper it might contain; upon which operation it came forth $33\frac{1}{2}$ grains, which was $2\frac{1}{2}$ grains leſs than it was before; afterwards this laſt was melted, with about two or three parts of ſilver, and ſo wrought in aqua-fortis for ſeparation of the ſilver; and their remained in gold but $28\frac{1}{2}$ grains and yet it appeared upon the touch not fine, but paler than fine gold, and deeper than crown gold allayed with ſilver; ſo that what remained in it was neceſſarily of ſilver, and it might be eſtimated about 23 carats fine, or to hold in fine gold about 27 grains; what the loſs of gold was by this refining with antimony may be eaſily computed; firſt, $14\frac{5}{6}$ grains for alloy being deducted from the firſt quantity of crown-gold weighing 178 grains, the remainder is $163\frac{1}{6}$ grains; then the ſeveral parcels of fine gold, which was recovered, and ſeparated from the *Regulus* of antimony and gold, and alſo from the parcels of crude antimony reduced to *Regulus*, are to be added together; that is, 30 grains, 63 grains, 27 grains and 27 grains, all which amount to 147 grains, and which deducted from the firſt quantity of $163\frac{1}{6}$, the difference is $16\frac{1}{6}$ grains, which is more than $\frac{99}{1000}$ or very near a tenth: Where and how this loſs of gold ariſes, appears thus; the firſt parcel of the antimony was charged with $163\frac{1}{6}$ grains of fine gold; of which the firſt *Regulus*, weighing 163 grains, in proportion to that piece of it weighing 38 $\frac{1}{2}$, and producing upon refining on the coppel 30 grains, muſt hold 127 grains of fine gold; then 27 grains of fine gold, eſtimated to be contained in the 36 grains ſeparated from this firſt parcel of antimony being added to the 127 grains makes 154 grains, which is ſhort of 163 $\frac{1}{6}$ grains by 9 $\frac{1}{6}$ grains, and ſo much was irrecoverably loſt in this parcel of antimony: Then the piece of *Regulus* weighing 124 $\frac{1}{2}$ grains melted with the ſecond parcel of antimony, in proportion to the former piece broken off, weighing 38 grains; and on refining yielding 30 grains of pure gold, muſt contain 98 grains of the like gold; and ſo much this ſecond parcel of antimony muſt be charged with; towards which the *Regulus* weighing 74 grains after refining produced 63 grains; and that gold, ſeparated from this ſecond parcel of antimony weighing 27 grains, being added, make 90 grains ſhort of the firſt quantity, charged upon this part of the firſt *Regulus*, by ſeven grains. There may be ſome loſs of gold upon powdering of the *Regulus*, as alſo by the papers neceſſarily uſed; but the greateſt loſs was by ſmall ſparks, which continually fly up, while the antimony is in a boiling heat with the gold, many whereof fly over the pot into the fire; that theſe ſparks were gold, appeared thus; when many of them ſtuck to an earthen cover, and had coloured it of a deep red, aqua-fortis did not fetch off, or diſſolve any thing, but aqua-regis run off yellow, like a ſolution of gold in the ſame water: There may alſo be ſome loſs of gold upon the firing of the antimony with tartar and nitre, which make a vehement conflagration with a copious ſparkling: It hath been ſuſpected that ſomewhat of the gold may be diſſipated by the blaſts upon the coppels, in refining it from the antimony remaining therein; but this is not ſo probable, becauſe refiners, to give their fine gold a higher colour for gilding, put to it a third or fourth part of crude antimony, or of *Regulus* of antimony, which is a conſtant practice among ſome of them, and with a great heat and ſtrong blaſt work it off; in which operation, in ſome ounces of gold, they loſe one grain.

There was melted 141$\frac{1}{2}$ grains of crown-gold with one $\frac{3}{4}$ ounce of antimony, and the *Regulus* weighed 123 grains, from this a piece weighing 30 grains was broken off, and reſerved for to be refined a-part; the remainder which was 93 grains was melted down again with the ſame antimony powdered and put on the top; and thereupon the *Regulus* came forth, weighing 91 grains, ſo that there was conſiderable loſs; and there is ground to ſuſpect, that it might be upon ſome accidental difference in the managing, that the *Regulus* did not ſo perfectly ſeparate and ſettle; for in all other experiments of melting the ſame *Regulus* again with the ſame antimony, the *Regulus* gained weight: From this ſecond *Regulus* a piece was broken off and reſerved to be refined a-part, weighing 36 grains, the remainder, which was 55 grains, was melted down, as the former, and in the ſame antimony; whereupon the *Regulus* came forth in weight 72 grains, 17 grains being gained: The firſt piece of 30 grains being refined on the coppel, produced 24 grains of fine gold; and the ſecond piece of 36 grains produced 28, grains and the *Regulus*, upon the third melting, of 27 grains produced 55 grains: So that each of the pieces contained about $\frac{4}{5}$ of gold, and but $\frac{1}{5}$ of antimonial ſubſtance, yet loſing ſomething of that proportion at each melting, tho' the *Regulus* gained in weight; the remaining antimony being reduced to a *Regulus* by firing with nitre and tartar, as before, and that *Regulus* fumed away upon the coppel, their remained of gold 19 grains; and this was not ſo fine as that extracted out of the firſt antimony in the former experiment; but this impurity was wholly from the alloy, and upon refining it firſt with lead upon the coppel for extracting the copper, it weighed 17 $\frac{1}{2}$ grains, having loſt one $\frac{1}{2}$ grain; and then with aqua-fortis, after the melting down with more than the double weight of ſilver, upon which occaſion there remained 15 grains, and that not perfectly fine, but retaining ſomewhat of ſilver, upon the touch about 23 carats. The loſs of gold is thus computed; from the firſt quantity of 141 $\frac{1}{2}$ grains, a 12th part or about 11 $\frac{5}{6}$ grains, being deducted for alloy, the remainder is 129 $\frac{4}{6}$ grains. And the ſeveral parcels of fine gold produced of the *Regulus*, according to the account given in particular, being 24 grains, 28 grains, 55 grains 14 $\frac{1}{2}$ grains; the whole makes 121 $\frac{1}{2}$ grain ſhort of the firſt quantity by 8 $\frac{1}{6}$ grains or nearly $\frac{1}{16}$.

A parcel of crown-gold weighing 82 $\frac{1}{2}$ grains was melted down with an ounce of antimony, and the antimony was made to fume away in a crucible to a *Regulus*; then the antimonial part of that *Regulus* was exhaled on a coppel; whereupon there remained 84 grains or one $\frac{1}{2}$ grain more than the firſt quantity; and this muſt happen for want of a heat ſtrong enough at laſt to force off all the antimonial ſubſtance; whence, upon melting in a crucible, it afterwards came forth 80 grains the 2 grains $\frac{1}{2}$ wanting, being leſs than the leaſt part of the proportion of copper, that muſt be in it, according to the uſual alloy of crown-gold; and that there remained copper in this gold appeared by its black colour upon nealing, as alſo by the loſs upon working it with lead on a coppel, whereupon it came forth only 76 grains; ſo that antimony in a far greater proportion is not ſo effectual as lead in exhaling or ſeparating copper from gold, but doth only retain it with itſelf, whilſt the gold ſeparates and ſettles in a *Regulus* at the bottom; neither is it ſo deſtroyed, but that it may in part at leaſt, be united to the gold again.

A Monſtrous Birth; *by Dr.* Sam. Morris. Phil. Tranſ. N° 138. p. 961.

THIS monſtrous female birth had two heads, both the faces were very well ſhaped; the left face looked ſwarthy, and never breathed; the left head was the biggeſt; the right was perceived to breath, but not heard to cry; betwixt the heads was a protuberance like another ſhoulder; the breaſt and clavicles were very large, about ſeven inches broad, it had only two hands and two feet: The brain in each head was very large, the backbone from the neck to the loins was double; there were alſo two hearts, one on each ſide the *Thorax*; the left was the largeſt; it had alſo two pair of lungs, one infolding each heart; thoſe on the left ſide were blackiſh, the other looked well; the *Mediaſtinum* ſeparated the two hearts from each other: The *Aorta* and *Vena Cava* below the diaphragm were ſingle, the diaphragm having only three perforations, as is uſual; but a little above it, they were each divided into two branches, diſtributed to the two hearts in the figure of a *Greek* Ψ; the gullet in like manner a little above the diaphragm, *viz.* about the fifth *Vertebra* was divided into two branches, one aſcending up into each throat: There were alſo two ſtomachs, the one naturally ſhaped, the other was a kind of a great bag; at one orifice it was continued with the true *Pylorus*, and at the other with the *Duodenum*; it contained a ſubſtance like *Meconium*, as is uſual in children newly born; there was only one liver, but very large, and the gall-bladder proportionable; the ſpleen was alſo ſingle, and large, as alſo the inteſtines; and all the parts of the lower belly, eſpecially the left kidney, were large; the *Uterus* was of a common ſize, but the *Clitoris* was large: The *Secundine* of an extraordinary magnitude, weighing about eight pounds.

Red Snow *near* Genoa; *by* Sig. Sarotti. Phil. Tranſ. N° 139. p. 976.

THERE fell upon the mountains, called *le Langhe*, a great quantity of red, or if you will, bloody ſnow, from which, upon ſqueezing, there came water of the ſame colour.

The Structure of the Noſe; *by M.* du Verney. Phil. Tranſ. N° 139. p. 976.

M. *DuVerney* obſerves, that the cavities of the noſe are filled with many cartilaginous *Laminæ* diſtinct from each other, every *Lamina* being divided into many others, all folded almoſt into a ſpiral line; and that the *Os Cribroſum* is made up of the extremities of theſe *Laminæ*, which terminate in the root of the noſe, the holes wherewith it is perforated being the intervals between the *Laminæ*; that they are deſigned to ſuſtain the inner coat of the noſe, which being a principal organ of ſmelling hath received from nature a very great expanſion, being folded round about together with theſe *Laminæ*, that by this contrivance all its length may take up a very little room: This coat is filled with many branches of arteries, veins, and nerves, whereby it hath a very exquiſite ſenſe; yet, becauſe the particles of odorous bodies are ſo ſubtile, that they cannot but very gently touch the organ; by this expanſion they are enabled to ſtrike a greater number of parts at once, and ſo render their impreſſion ſtronger; this coat is alſo furniſhed with a great many ſmall glands for moiſtening it, the better to entangle the dry odorous particles; the more exquiſite this ſenſe is in animals, the greater number of *Laminæ* they have; thus the noſe of a hound is better furniſhed with them than any other animal; and not only the number, but alſo the length of the *Laminæ* contributes to the ſenſe of ſmelling; for which purpoſe, moſt quadrupeds, as the carnivorous and graminivorous have their noſe not placed in the middle of their face as man, but lengthened to the very end.

Obſervations in Brazil *and* Congo. Phil. Tranſ. N° 139. p. 977.

IN *Brazil* there are certain little animals called *poüx de Pharaon*, *Pharaoh*'s lice, which enter into the feet between the ſkin and fleſh; they grow in one day as big as beans; and if they are not preſently extracted, they cauſe an intolerable ulcer, and the whole foot corrupts.

Amongſt the fruit-trees in *Brazil*, there is one, whoſe fruit is called *Niceffo*, with only two leaves; each of which is large enough to cover a man.

In the kingdom of *Congo* are ſerpents 25 foot long, which will ſwallow at once a whole ſheep; they are killed as they ſtretch and baſk themſelves in the ſun, and after cutting off their heads and tails, and embowelling them, the *Blacks* eat them, and they find them ordinarily as fat as hogs: The ants are ſo numerous and large, that the author reports, that being one day ſick a bed, he was forced to order himſelf to be carried out of his room, for fear of being devoured by them; as it often happens to thoſe of *Angola*; where you may alſo find in the morning the ſkeletons of cows devoured by theſe animals in one night.

A Child *twenty-ſix Years in the Mother's Belly, out of the* Uterus; *by Dr.* Bayle. Phil. Tranſ. N° 139. p. 979.

M*Argaret Mathew* being with child perceived about the end of the 9th month ſuch pains as women uſually have, when about to fall in labour; her waters alſo broke, but no child followed; for the ſpace of 20 years ſhe perceived this child to ſtir with many troubleſome ſymptoms; but for the 6 laſt years ſhe did not feel it move: She died *June* 18th, 1678; and being opened, a dead child was found in her belly without the womb, in no manner joined or faſtened to it, with the head downwards, the buttocks hanging towards the left ſide; all the back part of this child was covered with the *Omentum*, which was about 2 fingers thick, and adhered cloſe to ſeveral parts of its body, not to be ſeparated without a knife, and yet no blood enſued: This child weighed 8 pounds *Averdupois*; the ſcull was broken into ſeveral pieces; the brain of the colour and conſiſtence of ointment of roſes; the fleſh red, where the *Omentum* adhered; other parts whitiſh, yellowiſh, and ſomewhat livid, except the tongue, which had its natural colour and ſoftneſs; all the inward parts were diſcoloured with a blackiſhneſs, except the heart, which was red, and without any blood: The forehead, ears, eyes, and noſe were covered with a callous ſubſtance, a finger's breadth thick: Upon cutting the gums, the teeth appeared as in grown perſons: The body had no bad ſmell, tho' kept 3 days after it was taken out of the mother's belly: The length of the body from the buttocks to the top of the head was about 11 inches: The mother died about the 64th year of her age.

A Woman Hydropical *on her left Teſticle*; *by Dr.* Hen. Sampſon. Phil. Tranſ. N° 140. p. 1000.

THIS woman was about 50 years old, was married, but never had any child, and had been a widow for 10 years before her death; in which time ſhe was much oppreſſed with grief, and her belly by degrees began to ſwell; yet not much, till about 4 years before ſhe died: In 1677, at which time ſhe weighed 216 *lb.* Dr. *Sampſon* adviſed her to the uſe of cathartic hydragogues and diuretics; after the uſe of which for ſome time, ſhe weighed but 200 *lb*; but ſtill the morbific matter was re-accumulated to the diſeaſed part; ſo that reſolving to forbear further medicines, within half a year after ſhe weighed 250 *lb*; her belly being at laſt ſo far diſtended, as to hang down as ſhe ſat, a good way below her knees: Upon opening her, there was diſcharged about 20 *lb.* of a browniſh water or *Serum*, from one of the veſicles of the left *Ovarium*; and having ſeparated the muſcles of the *Abdomen*, there was no *Serum* nor hydropic water found, but a heap of bladders of ſeveral ſizes preſented themſelves; from the largeſt of which there iſſued about 20 *lb*, more of a brown and thickiſh *Serum* with a ſediment of the colour of amber; ſome of the leſſer were about the bigneſs of a child's head, yielding a ſlimy *Serum*, in conſiſtence and colour like the mucilage of quince-ſeeds; others were much leſs, ſome as big as a man's fiſt, ſome as an ordinary apple, others as a walnut; moſt of which contained a *Serum* like the white of an egg; in ſome of them not quite ſo viſcous, and ſomewhat white, like ſtarch newly boiled: At length he perceived, that all theſe bladders were parts ſome way relating to the womb; wherefore, having ſeparated the *Oſſa Pubis*, he took out the womb; and then he obſerved, that the right teſticle or ovary was but ſmall and white, and its veſicles in a manner dried up, but the left was ſwelled to a vaſt bulk; the above-mentioned bladders, in one of which were contained ſo many pounds of liquor, being nothing elſe originally but the *Ova* belonging to this left *Ovarium*: The teſticle or ovary itſelf, when emptied of all the *Serum*, weighed together with the womb, which was but light, 25 *lb.* and the quantity of *Serum* amounted to upwards of 112 *lb.*

A Clock

A Clock *aſcendent upon an inclined Plane*; *by* M. de Gennes. Phil. Tranſ. N° 140. p. 1006.

FIG. 4. Plate IV. repreſents the inſide of the machine placed upon an inclined plane; the whole invention conſiſts in a weight, which cauſes the machine to work in the following manner: The circle F G H being placed upon an inclined plane A B is divided into two unequal parts by the line G I; in order to reſtore to the leſſer ſection its *Æquilibrium*, there is faſtened to the extremity of the radius D F, a weight F; that a wheel or clock may thus ſtand not only in *Æquilibrium*, but alſo aſcend upwards, there is a drum placed in the middle of the clock, which incloſes the ſpring of the pendulum, on which drum the radius D F is faſtened; for thus the ſpring being mounted forces the drum to turn, and ſo to raiſe the weight, which it cannot do without its becoming more heavy, in regard that coming to the point E, it is farther from the centre, than when it was in F, and thus the wheel turns on that ſide as the ſpring gives way.

An Engine *to make* Linnen-cloth: *by* M. de Gennes. Phil. Tranſ. N° 140. p. 1007.

THIS engine is no other than a mill, to which are applied all the parts of a weaver's ordinary loom; it conſiſts of four principal parts; *viz.* the ſerpent A A Fig. 5. Plate IV. two footſteps or treddles B B, one clapper C, and two arms D D, D D: The ſerpent or iron bar A A has two elbows E E, to which the ends of the rope are fixed that raiſe and depreſs the treddles B B; F F are two fourths of a circle, that ſucceſſively reſt upon two arches or bows of iron G G, which are above the clapper C, in order to raiſe it; H H are two teeth of iron, added to the ſerpent, making an angle of 25 degrees with F F and K K, ſerving to depreſs a *Bacule* or ſweep, which is in the arm that carries the ſhuttle; the treddles differ not from the common, only the cords that hold them pendulous are fixed in the elbows of the ſerpent, which in turning raiſes and depreſſes them by the help of two little pulleys, on which the ropes turn: The clapper is ſupported between two pillars with a rope double twiſted, which cauſes it to make a kind of ſpring, and naturally to yield forwards to beat the cloth; L M is one of the arms which paſſes freely into the canal or pipe N N, ſupported by four pillars of wood, O O O O; its motion proceeds from the following parts, P Q is a *Bacule*, which tho' unequally divided by its ſupporter R, is yet in *Æquilibrio*, the end P R being made to weigh exactly as much as R Q: At the extremity of this *Bacule*, is tied a cord, which paſſes thro' the pulley S, and terminates at the extremity of the arm, where it is faſtened to a little bowl M; at the other extremity of the ſame arm; that is, towards L, is alſo faſtened underneath a cord, which paſſes thro' the pulley T, and which carries the weight U: At the ſame end of the arm is added a little niche Z, about the bigneſs of half the ſhuttle; then over a little bar X Y, which paſſes a-thwart the arm, there are two other little pieces of wood, with two teeth at the end, which enter into the niche Z thro' two holes on one ſide and the other: To the ends of theſe little pieces of wood is a little bow of whale-bone or ſteel, which keeps the two ends aſunder, and forces the teeth, which are at the other end, to enter into the niche, before the ſaid pieces themſelves; at the points 1 1 are two ropes that paſs thro' the pulleys 2 2, faſtened to the pillars 0 3 0 4, each of them having a little weight at the end big enough to keep it from paſſing thro' a little bowl which is under each pulley: This arm ſo diſpoſed goes and comes into the hole N N in the following manner; a tooth of the ſerpent already deſcribed ſtrikes upon the extremity of the *Bacule* P Q, and ſo cauſes the end Q to riſe up, which drawing the cord faſtened to the point Q, makes the arm L M to advance forwards; but when afterwards the tooth of the ſerpent is come out, then the weight U tied to the other end of the ſame arm by a cord which paſſes thro' the pulley T, forces the ſaid arm by its weight to return again: When the arm L M is in its ordinary place, the two little pieces of wood into which the bar X Y enters, encloſe the ſhuttle by means of the whale-bone ſpring; but when the ſaid arm aproaches the other oppoſite arm, then the cords tied to the points 1 1, being a little too ſhort, and the weight at their ends not being able to paſs thro', the ſpring gives way a little, and ſo the ſhuttle is no longer encloſed by the arm which carries it, but is wholly received and graſped by the other, which likewiſe in its turn, delivers it back again in the ſame manner.

The motion of the whole machine is in proportion to that of the handle of the ſerpent; for then the arms cauſe the threads to open, and immediately one of the arms begins to ſlide in towards the oppoſite arm, to which it carries the ſhuttle and retires immediately; at the ſame time one of the quarters of a circle, which held the clapper elevated, retires, and leaves it to flap, and again the oppoſite quarter of a circle elevating itſelf, the other elbow changes the threads, and the other arm retires, and thus ſucceſſively.

The advantages of this machine are theſe: 1. One mill will ſet 10 or 12 of theſe looms a-going. 2. You may make the cloth of what breadth you pleaſe. 3. There will be fewer knots in the cloth, ſince the threads will not break ſo faſt as in other looms, becauſe the ſhuttle, by which the threads are generally broken, can never touch them; in a word the work will be carried on quicker and at leſs charge, in regard that inſtead of ſeveral work-men which are required in making very large cloths, one boy will ſerve to tye the threads at the ſeveral looms as faſt as they break, and to order the quills in the ſhuttle.

A Conjecture at Diſpoſitions from the Modulations of the Voice. Phil. Tranſ. N° 140. p. 1011.

THE author obſerved that in ordinary diſcourſe words were ſpoken in perfect notes, and that ſome of the company uſed eights, ſome fifths, ſome thirds; and that the words of the perſons diſcourſe which was moſt agreeable, as to their tone, conſiſted for the moſt part of concords, and where of diſcords, of ſuch as conſtituted harmony; and the ſame perſon was obſerved to be moſt affable, pleaſant and beſt natured in the company; and this ſuggeſts a reaſon, why many diſcourſes which one hears with much pleaſure, when they come to be read ſcarce ſeem the ſame things: From this difference of muſick in ſpeech, we may conjecture that of tempers; the *Doric* mood ſounds gravity and ſobriety; the *Lydian*, freedom; the *Eolic* ſtillneſs and compoſedneſs; the *Phrygian* jollity and youthful levity; the *Ionic* ſooths the ſtorms and diſorders of the paſſions; and it may be reaſonably ſuppoſed that ſuch whoſe ſpeech naturally runs into the notes peculiar to any of theſe moods, are in diſpoſition ſimilar: The ſame thing may be ſhewn from the cliff as he that ſpeaks in gammut to be manly; in C F a Ut to be of an ordinary capacity, tho' good diſpoſition; G Sol Re Ut, a man to be peeviſh and effeminate and of a weak and timorous ſpirit; ſharps ſhew an effeminate ſadneſs as flats do a manly melancholy; and a perſon that has a voice in ſome meaſure agreeing with all cliffs ſeems to be of good parts and fit for variety of employments, yet ſomething inconſtant in his nature: A conjecture may likewiſe be made from the times; thus ſemi-briefs may beſpeak a dull and phlegmatic temper; minims a grave and ſerious diſpoſition; crotchets, a prompt wit; quavers, vehemency of paſſion, and theſe are uſed by ſcolds; a ſemi-brief reſt may denote one either ſtupid, or fuller of thoughts, than he can utter;

minim-reſt, one that deliberates; crotcheſt-reſt, one in a paſſion: ſo that from the natural uſe of mood, note and time, we may collect diſpoſitions.

The making of Microſcopes; *by Mr.* Butterfield. Phil. Tranſ. N° 141. p. 1026.

MR. *Butterfield* tried ſeveral ways for the making of glaſſes from the bigneſs of a great pins head or leſs, as in the flame of a tallow-candle, or one of wax, but the beſt method of making them clear and without ſpecks, was in the flame of ſpirit of wine well rectified and burning in a lamp; inſtead of cotton he made uſe of very ſmall ſilver wire doubled up like a ſkean of thread; then he took up his beaten glaſs, after firſt waſhing it very clean, upon the point of a ſilver needle filed very ſmall and wet with ſpittle, holding the bit of glaſs in the flame till it was quite round, and no longer for fear of burning it; and if the ſide of the glaſs next the needle was not melted, he preſented the rough ſide to the flame, till it was every where equally round and ſmooth; then he wiped and rubbed it with ſoft leather; and afterwards put it between two pieces of thin braſs, the apertures being very round, and that towards the eye as large almoſt as the diameter of the glaſs, and ſo placed in a frame with the object.

The Speaking Trumpet *improved*; *by Mr.* J. Conyers. Phil. Tranſ. N° 141. p. 1027.

THIS reflecting trumpet conſiſts of two parts; B*b* Fig. 6. Plate IV. is a large concave pyramid, about a yard long, or it may be of any manageable length, open at the baſe, and terminated in a concave head at the cone B; within this is faſtened a bended tube A*a*: This trumpet at a meeting of the Royal Society in *Arundel-houſe* did diſtinctly convey ſome words croſs the garden and the river *Thames*, even againſt the wind which then was ſtrong, and the words were written down by a perſon ſent over for that purpoſe; whereby it appeared that a reflecting-trumpet; made after this or ſome other like manner, of wood, tin, pewter, ſtone or earth, or which may be beſt, of bell-metal, will carry the voice as far, if not farther than the long one invented by Sir *Sam. Moreland*; beſides that it ſeems to take off from the frightful noiſe, which happens near at hand in the uſe of the long trumpet: By Sir *Sam. Moreland*'s trumpet Fig. 7. angularly arched in the middle, the delivery of ſound to any diſtant place was much ſhortened; and by another Fig. 8. with three large angular arches, reaching nearly from end to end, the ſound was almoſt wholly obſtructed.

An Abſceſs in the Liver, Stones *in the* Gall-bladder *and conjoined* Kidneys; *by Dr.* Edw. Tyſon. Phil. Tranſ. N° 142. p. 1035.

THE liver was obſerved in this ſubject to be very large and faſtened to the diaphragm in an unuſual manner, and the colon ſo firmly joined to the liver, near the gall-bladder, that it could not be ſeparated without inciſion; the gibbous part of the liver towards the right ſide appeared diſcoloured, in which making an inciſion, there iſſued out plentifully a perfect pus, which was very fœtid, as alſo from a wound made in its concave part near the fiſſure; this purulent matter was not contained in any *Cytis* or bag, but in ſeveral *Sinus*'s in that part of the liver; whereas the other parts ſeemed ſound and well coloured: This abſceſs might well be preſumed the cauſe of that lurking fever that took off the patient, and under which he laboured about ſix weeks, yet without much complaint of ſickneſs, being only troubled with irregular heats, and ſometimes ſuch as were imperceptible to the patient himſelf; he had twice or thrice, but at great intervals, proxyſms of cold fits like an intermittent fever, but a fœtor and drineſs in his throat as proved obſtinate to all medicines. His approaching death was attended with other ſymptoms that uſually follow the affection of the brain and nervous ſyſtem; the patient had formerly been often ſubject to the yellow jaundice.

The gall-bladder was full of ſtones, as alſo the *Meatus Cyſticus* and *Ductus Communis* as far as the *Duodenum*, and ſeveral ſmall ſtones were found in the *Porus Bilarius*; there was no fluid gall in the bladder, but ſome that was ſoft, and of a deep yellow oker colour that filled up the interſtices of the ſtones; theſe ſtones were of various bigneſſes from a nutmeg to a pepper corn, of a darkiſh yellow oker colour, altho' in ſome there appeared *Laminæ* of a browner colour; when a little dry they ſeemed ſoapy to the touch; they were light, and their ſcent very fœtid like that of the purulent matter in the liver; they were friable, and generally of a triangular figure, or inclining thereto, but all were angular; the ſides next the gall-bladder were protuberant and convex, the other two ſides were flat, ſo that having the leſſer angle towards the centre of the cavity of the gall-bladder, like ſo many wedges they filled it the more compleatly, and they were more than thirty in number.

The ſtructure and conjunction of both kidneys were uncommon, the parenchyma of the one being continued over the ſpine to the other, ſo that they both made but one continued ſemilunar body; they were very large, and the part that conjoined them and lay over the ſpine was ſomething ſmaller than the true kidneys, with three ſeams on its external membrane, tho' internally the parenchyma ſeemed not to obſerve ſuch a diviſion, but was the ſame with the ſubſtance of the kidneys; the emulgent veſſels were very numerous; for beſides two larger veins that were ſubdivided into ſeveral leſſer ramifications, there were divers others that were ſingle, even to their inſertion into the *Vena Cava*; the middle part, by which both kidneys were conjoined, was alſo plentifully provided with blood-veſſels; for it received from the *Aorta* two arteries which before their inſertion were each ſubdivided into three branches, and it ſent out two veins, which, afterwards uniting into one, entred the *Vena Cava*; beſides at the ſeam in the lower part of the left kidney there was a vein and artery, which afterwards inſerted themſelves into the *Iliac* branches of the *Aorta* and *Cava*; ſo that nature, tho' ſwerving from her wonted rule in forming this part, yet was provident in furniſhing it with veſſels; there were only two *Ureters*, but the *Pelvis* in each kidney was remarkably dilated, and that of the left was the largeſt, having a triple origination; the right had but a ſingle one and was leſs.

Dr. *Tyſon* was of opinion that this ſtructure of the kidneys might occaſion both the dilatation of the *Vena Cava*, and of the *Pelvis*; for the middle part that conjoined both the kidneys, lying over the *Vena Cava*, would by its weight hinder the free return of the blood, and thereby enlarge its own channel; ſo likewiſe the *Ureters* running over that part that conjoined the kidneys, might in ſome poſitions of the body have their paſſage ſo ſtraitened, that the urine being hindred and regurgitating might ſwell and ſtretch the membrane of the *Pelvis* to that capacity.

A Fig. 9. Plate IV. is the right kidney; B the left; C the middle part conjoining both kidneys; *d e f* three ſeams in the coat of the kidneys; G the *Aorta*; *h h* two arteries from the *Aorta*, which are afterwards ramified into three, and ſo inſerted into the ſaid middle part; I the *Vena Cava*; K K two veins ariſing from the middle part, which uniting into one, entred the *Vena Cava*; L M, a vein and artery ariſing at the ſeam *f*, which at laſt are both inſerted into the *Iliac* branches of the

Aorta and *Vena Cava*; N M the emulgent arteries; O O the emulgent veins; whereof ſome are ſingle and others variouſly ramified; P P the *Pelvis* of both kidneys, that of the left being very large; Q Q the two *Ureters*.

Four Ureters *in a* Child; *by Dr.* Edw. Tyſon. Phil. Tranſ. N° 142. p. 1039.

UPON opening the body of an infant, there was obſerved a double *Ureter* to each kidney; their origination in the kidneys were at ſome diſtance from each other, but afterwards the two on the ſame ſide were incloſed in a *Capſula* or membrane, that reached to the bladder, where thoſe of the right ſide were inſerted ſeverally, yet near each other; but on the left they ſeemed to enter at one and the ſame orifice: The *Glandulæ Renales* in embryo's and infants are larger proportionably than in adults; Dr. *Tyſon* found they had a large cavity each, which, by blowing into them emptied themſelves into two veins, the right paſſing into the *Cava* and the left into the emulgent.

A Fig. 10. Plate IV. the right kidney, whoſe ſurface ſeemed to be variouſly divided; B the emulgent vein; C the emulgent artery; *d d* two *Ureters* belonging to this kidney: Fig. 11. repreſents the two *Ureters* of the left kidney, which a little below it are both encloſed in a common *Capſula* or caſe, and ſo continued to the bladder: A Fig. 12. is the *Glandula Renalis* of the right ſide; B that of the left; C the *Vena Cava*; *d* a vein or *Ductus* opening from the cavity of this gland, and entring the *Cava*; *e* a vein from the left *Glandula Renalis* inſerted into a branch of the left emulgent.

The Art of Refining; *by Dr.* Chr. Merret. Phil. Tranſ. N° 142. p. 1046.

THE deſign of this art is the ſeparation of all other bodies from gold and ſilver; which is done four ways; *viz.* by parting, by the teſt, by the almond-furnace, or the ſweep, and by mercury.

Parting is done with aqua-fortis, which the refiners make thus, take ſaltpetre three pounds, *Dantzic* vitriol two pounds; let them be well pounded and mixed in a mortar, and then put into a long-neck, an earthen-veſſel ſo denominated from its figure; then ſix or eight of theſe long necks thus filled, are placed in each ſide of the furnace in a range built with iron bars, of the form of a parabola, at above nine inches diſtance from each other, and cloſed at the ſides with bricks; the upper arches are left open to put in and take out the pots; over the ſaid arches they lay large bars of iron, and then they cover all the top of the furnace with loam, the body of each long neck lying expoſed to the fire, and the neck without, to which the receivers either of glaſs or *German* pots are well luted: Obſerve that if it be not *Dantzic* vitriol, which is made with copper, but *Engliſh* which is made of old iron, the water will be weaker, and make a dirty coloured verditer and wholly ſpoil it; beſides the ſilver will not gather ſo well to the copper after ſolution, and thereby becomes black; the lute is made of good loam, ſome horſe dung, and a little colcothar, altho' the two former do well; the luting being well wrought and applied, they make a gentle charcoal fire under the pots for three hours, and then they increaſe it for three hours more; about the ſeventh hour, they make a vehement hot fire for four hours, and caſt in towards the end well dried billets of the length of the furnace, whoſe flame ſurrounds all the pots, and finiſhes the work; next morning the receivers are carefully ſeparated from the long necks; this work is uſually performed but once in 24 hours, and ſometimes twice: Some refiners diſtill 100 weight of the materials in a caſt iron-pot in a furnace of this invention; *viz.* two yards high or upwards, into which the iron pot is put in at the top, and thereto a head of earth fitted, like that of a large diſtilling alembic for chymical oils, with a large belly running out into three branches eight inches from the iron-pot, the middlemoſt proceeding directly forwards, the two lateral ones obliquely, four or five inches in diameter, and five or ſix long; to theſe branches glaſs bodies are fitted, narrow and hollow at both ends, large and globular in the middle, which are to be well luted on with colcothar, rags, flower and whites of eggs; to this firſt glaſs-body is luted on another glaſs of the ſame figure and ſize, and eight ranged in order, till they come to the receiver which is an ordinary gallon glaſs; all theſe rows of glaſſes lie on boards ſhelving from the head to the receiver; the two upper receivers or glaſs-bodies require exceeding good luting, for the others common luting will ſerve; the conveniency of this method is, that a little fire, and that of *Newcaſtle* coal will do the work, that you ſave a long-neck for each five pounds of materials, and that you need not break or unlute any of the receivers but the lowermoſt. The aqua-fortis being diſtilled off is put into a large earthen pot, and there is added of fine ſilver, one or two penny weight, which is called fixes, to every pound of *Aqua-fortis*, which in four hours will purge it from all dirt and impurity, and make it fit for parting, which is thus done; if the ſilver gilt be fine enough for wire, they only melt it in a wind-furnace, and caſt it melted into a large tub of water, to have it in ſmall pieces; but if it be only ſtandard, they firſt fine it on the teſt; theſe ſmall pieces taken out of the water, and well dried, are put into a tapering-glaſs, a foot high, and ſeven inches at bottom; and then the glaſſes are about two thirds charged with *Aqua-fortis*, and ſet in a range of iron covered two inches deep with ſand, with a gentle charcoal fire under it; there will ſoon ariſe ſmall bubbles, and the water will alſo run over; in which caſe, they take off the glaſſes till they ceaſe to boil, or elſe pour ſome of it into a veſſel; if lead be mixed with it, there is no preventing its running over; after the ebullition of the water has once ceaſed, it will riſe no more; the greenneſs of the water ſhews the quantity of copper contained therein; if the water boil over, it will penetrate the bricks and wood; they commonly let it ſtand a night on the iron range, with a gentle heat under it; and in the morning, they gently pour off the water impregnated with all the ſilver, the gold lying like black dirt at the bottom; and which being waſhed out is put into ſmall parting-glaſſes, and ſet over the ſand with fair conduit-water for an hour, and then the water poured off; this is repeated five or ſix times, to ſeparate the ſalt from the gold, which is now fit to be melted, and caſt into an ingot; for regaining the ſilver, they uſe large round waſhing-bowls lined within with melted roſin and pitch, for otherwiſe the water would eat the wood and penetrate the ſides of the bowl, and covered with copper-plates ten inches long, ſix wide, and a half or more thick; into theſe bowls they pour a great deal of water, the more the better the verditer, and then the ſilver-water, which working on the ſofter metal of copper, leaves all the ſilver in fine ſand at the bottom, the ſides of the bowl, and on the plates of copper, which being taken out is waſhed, dried, and melted for any uſe; as to the plates it is obſervable, that if they contain any braſs or ſhruff metal, they gather very little of the ſilver, the latter mixing with it: Verditer is made of the copper-water poured off from the ſilver, and whiting in this manner; 100 pound weight of whiting is put into a tub, on which the copper-water is poured, and then they are ſtirred together every day for ſome hours together; and when the water grows pale, they take it out, and ſet it by for further uſe, and pour on more of the green water, and thus continue doing till the verditer is made; which being taken out is laid on large pieces of chalk in the ſun, till it be dry for the market: The water taken from the verditer is put into a copper, and boiled to the conſiſtence of water-gruel, now principally conſiſting of ſalt-petre reduced; moſt of the ſpirit of vitriol being gone with the copper into the verditer; a diſh-full whereof being put into the other materials for *Aqua-fortis*, is re-diſtilled, and makes a double water, almoſt twice as good as that which is without it.

All metals are ſeparated by the teſt from ſilver except gold, becauſe they ſwim upon it when they are all melted together: The teſt is thus made; there is an oval iron mould two inches deep, with three arches of iron at bottom, ſet at equal diſtances and two fingers wide, if its great diameter be 14 inches long, and ſo proportionally in greater or leſſer teſts; this cavity is filled with fine powder of bone-aſhes, moiſtened with *Lixivium*, made of ſoap-aſhes; ſome uſe cakes of pot-aſhes, or other aſhes well cleanſed, which preſſed well together with a muller, become very cloſe and ſmooth at the top; above in the middle is left a cavity to contain the melted ſilver, which is largeſt in the middle; for the bone-aſhes come up parallel to the circumference of the mould, only there is a ſmall channel in that end the moſt remote from the blaſt for the running off of the baſer metals, made ſloping to the centre of the teſt, where it is not above half an inch deep: The teſt thus made, is ſet a nealing 24 hours, and then put into a chimney a yard high, almoſt parallel to the noſe of a great pair of bellows; and then the ſilver is put into it, which being covered all over with billets of barked oak, the blaſt begins, and continues ſtrong all the while; the lead purified from all the ſilver, which they call the ſoap of metals, is firſt put in, and melts down with the ſilver, and then the lead and copper ſwim a-top, and run over the teſt, whoſe motion the refiner promotes with a long iron rod, drawn along the ſurface of the ſilver towards the fore-mentioned ſlit, and the metal is often ſtirred, that impurities may the better riſe; and by continuing thus to do, the ſeparation is made in two or three hours; and the greateſt part of the lead is made to fume away; if the lead be gone before the copper, the metal will riſe in ſmall red fiery bubbles, and then it is ſaid to drive, and more lead muſt be added; the force of the blaſt drives the upper metals to the lower ſide of the teſt, and promotes its running over: When the ſilver is fully refined, it looks like very pure quickſilver, and then they take off their ſogs, and let it cool; in the cooling, the ſilver will frequently ſpring up from the middle in ſmall rays, and fall down again; if moiſt ſilver be put into that which is melted, it will fly into the fire: A good teſt will ſerve two or three firings: As ſoon as the ſilver will hold together, they take it out of the teſt, and beat it on an anvil into a round figure for the melting-pot, which put into a wind-furnace ſurrounded with coal, and covered with an iron cap, that no charcoal fall into it, is then melted: If any droſs or filth be in the melting-pot, they throw in ſome tincal, which collects the droſs that it may be ſeparated from it: Theſe melting-pots are never burned, but only dried, and will laſt a whole day, if not ſuffered to cool, for in that caſe they infallibly crack.

In the almond-furnace, or ſweep, all ſorts of metals are ſeparated from cinders, parts of melting-pots, teſts, bricks, and all other harder bodies, after they are firſt beaten ſmall with a hammer on an iron plate; thoſe which ſtick but ſuperficially to the ſilver are waſhed off in this manner; they have a wooden round inſtrument two foot wide, ſomewhat hollow in the middle, with a handle on each ſide, on this the materials are put and held in a tub of water below its ſurface, and thus waving it to and fro, all the looſer and lighter matter is ſeparated from the metal: The furnace is ſix foot high, four foot wide, and two foot thick, made of brick, with a hole in the middle of the top eight inches over, growing narrower towards the bottom, where at the fore part it ends in a ſmall hole, encompaſſed with a ſemicircle of iron to hold the melted metal; about the middle of the back is another hole to receive the noſe of a great pair of bellows: When the furnace is annealed with charcoal, and hot, they throw two or three ſhovels of coal to one of the above-mentioned materials, and thus they proceed during the whole work, which continues three days and nights without intermiſſion; in eight or ten hours the metal begins to run, and when the receiver below is pretty full, they lade it out with an iron ladle, and caſt it into ſows in cavities or forms made with aſhes; the paſſage hole is frequently ſtopped with cinders to keep in the heat; and when they think a quantity of metal is melted, they unſtop the hole to paſs it off: If the matter be hard to flux, they throw in ſome ſlag, which is the recrement of iron, to give it fuſion: A ſtinking blue ſmoke proceeds from the furnace, and all the by-ſtanders look like ſo many dead men: In order to obtain the ſilver from theſe metals, and refine the copper from the litharge, they now uſe no other art than that of the teſt.

By quickſilver the filings of gold and ſilver are ſeparated from duſt, *&c.* which is put into a hand-mill with quickſilver, and made into an *Amalgama*, and the duſt is carried off by fair water poured upon it, and running out again by a ſmall quill; this *Amalgama* is put into an iron veſſel with a bolt head ſet in the fire, having a long iron neck three foot long, to which a receiver is fitted; the mercury is diſtilled off into the receiver, and the gold and ſilver remained in the bolt-head.

Allum-Works; *by Dr.* Dan. Colwal. Phil. Tranſ. Nº 142. p. 1052.

ALLUM is made of a ſtone dug out of a mine, of ſea-weed and urine; the ſtone is found in moſt of the hills between *Scarborough* and the river *Tees* in the county of *York*, as alſo near *Preſton* in *Lancaſhire*; it is of a blueiſh colour, and will cleave like *Corniſh* ſlate; that mine which lies deep in the earth, and is indifferently well moiſtened with ſprings is the beſt; the dry mine is not good; and again, too much moiſture cankers and corrupts the ſtone and makes it nitrous: In this mine are found ſeveral veins of ſtone called *Doggers*, of the ſame colour, but not ſo good; here are alſo found, thoſe commonly called *Snake-ſtones*: For the more convenient working of the mines, which ſometimes lie twenty yards under a ſurface or cap of earth, they begin on the declivity of a hill, and where they may be well furniſhed with water; the mine is dug down by ſtages to ſave carriage, and ſo the mineral is thrown near the places where they calcine it; being expoſed to the air before calcination, it will moulder in pieces, and yield a liquor of which copperas may be made; but on being calcined, it is fit for allum; as long as it continues in the earth or in water, it remains a hard ſtone; there will ſometimes iſſue out a liquor from the ſide of the mine, which by the heat of the ſun becomes natural allum: The mineral is calcined with cinders of *Newcaſtle* coal, wood, and furzes; the fire is made about two foot and a half thick, two yards broad, and ten yards long; betwixt every fire are diviſions made of wet rubbiſh, ſo that any one or more of them may be kindled, without prejudice to the reſt: After that, eight or ten yards thickneſs of broken mineral are laid on this fuel, and five or ſix of them are ſo covered; they then begin to kindle the fires, and as the flame riſes towards the top, they lay on freſh mineral; ſo that to what height ſoever the heap be raiſed, which is often about 20 yards, the fires without any further fuel, will burn to the top, and that ſtronger than at the firſt kindling, ſo long as any ſulphur remains in the ſtones: In calcining them the wind may often do hurt, by forcing the fire in ſome places too quickly thro' the mineral, and leaving it black and half burnt; and in other places burn too much, and leave it red; but where the fire paſſes gently, and of itſelf, the mineral remains white, and it yields the beſt and greateſt quantity of liquor: The mineral, when thus calcined, is put into pits of water, ſupported with wooden frames, and rammed on all ſides with clay, about ten yards long, five yards broad, and five foot deep, ſet with a current, that turns the liquor into a receptacle, from whence it is pumped into another pit of mineral, ſo that every pit of liquor, before it comes to boiling, is pumped into four ſeveral pits of mineral, and every pit of mineral is ſteeped in four ſeveral liquors, before it be thrown away, the laſt pit being always freſh mineral; this mineral thus ſteeped in each of the ſeveral liquors about 24 hours, is of courſe four days in paſſing the four ſeveral pits, from whence the liquors paſs to the boiling-houſe: The water, or virgin-liquor often gains in the firſt pit two pound weight, in the ſecond it encreaſes to five, in the third to eight, and in the laſt pit, which is always freſh mineral, to twelve pound weight, and ſo in proportion to the goodneſs of the mineral and its degree of calcination; yet often liquor of ſeven or eight pound weight yields more allum than that of ten or twelve, either from the badneſs of the mineral or as uſually, from the bad calcining of it; and if by paſſing the weak liquor thro' another pit of freſh mineral, you bring it to ten or twelve pound weight, yet the quantity of allum will be leſs than when it was but eight; for what it gains from the laſt pit of mineral, will be moſtly nitre and ſlam, which ſpoil the good liquor, and diſorder the whole houſe, till the ſlam be wrought out; what they call ſlam is firſt perceived by the redneſs of the liquor, when it comes from the pit, cauſed either by the badneſs of the mineral, or as is commonly the caſe, the over or under calcining it, which in the ſettler ſinks to the bottom, and there becomes of a muddy conſiſtence and dark colour; that liquor which comes whiteſt from the pits is the beſt: When a work is firſt begun, they make allum of the liquor only that comes from the pits of mineral without any other ingredients, and ſo they might continue to do, but that it would ſpend ſo much liquor as not to quit coſt.

Kelp is made of a ſea-weed called *Tangle*, it grows on rocks by the ſea ſide, between high and low water mark, when dry it will burn and run like pitch, when cold and hard it is beaten to aſhes, which are ſteeped in water, and the lees are drawn off to two pound weight or thereabouts: Becauſe the country people, who furniſh the works with urine, do ſometimes mix it with ſea water, which cannot be diſcovered by the weight, they try it by putting it to ſome of the boiling liquor; for if it be good, it will work like yeaſt put to beer or ale; but if adulterated, it will have no more effect than ſo much water: It is obſerved, that the beſt urine is that of poor labouring people, who drink but little ſtrong liquors.

The boiling-pans are made of lead, nine foot long, five foot broad, and two and a half deep, ſet upon iron plates about two inches thick, which pans are commonly new caſt, and the plates repaired five times in two years: When the work is begun, and allum once made, then they ſave the liquor which comes from the allum, or wherein the allum ſhoots, which they call *Mothers*; with this they fill two thirds of the boilers, and put in one third of freſh liquor which comes from the pits; being thus filled up with cold liquor, the fires having been never drawn out, they will boil again in leſs than two hours time; and every two hours the liquor will waſte four inches, and then the boilers are filled up again with green liquor: The liquor, if good, will ſeem greaſy a-top; if nitrous, it will be thick, muddy, and red; in boiling 24 hours, it will be 36 pound weight, then about a hogſhead of the lees of kelp is put into the boiler, of about a two penny weight, which will reduce the whole boiler to about 27 pound weight; if the liquor be good; as ſoon as the lees of kelp are put into the boiler, they will work like yeaſt put to beer; but if the liquor in the boiler be nitrous, the kelp-lees will affect it but very little; and in that caſe, the workmen muſt put in the more and ſtronger lees; immediately as the kelp-lees are put into the boiler, all the liquor is drawn into a ſettler, as large as the boiler, made of lead, in which it ſtands about two hours, and in that time moſt of the nitre and ſlam ſink to the bottom; this ſeparation is made by means of the kelp-lees; for when the whole boiler conſiſts of green liquor drawn from the pits, it is ſtrong enough to throw off the ſlam and nitre; but when *Mothers*

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thers are uſed, the kelp-lees are needful to make the ſaid ſeparation; then that liquor is ſcooped out of the ſettler into a cooler, made of deal boards, and rammed with clay; into this is put 20 gallons more or leſs of urine, according to the goodneſs or badneſs of the liquor; for if the liquor be red, and conſequently nitrous, the more urine is required; in moderate weather the liquor ſtands four days in the cooler; the ſecond day the allum begins to ſtrike, gather, and harden about the ſides and at the bottom of the cooler; if the liquor ſhould ſtand in the cooler above three days, it would, as they ſay, turn to copperas; the uſe of urine is both to caſt off the ſlam, and keep the kelp lees from hardening the allum too much: In hot weather the liquors will be a day longer in cooling, and the allum in gathering, than when the weather is temperate; in froſty weather the cold ſtrikes the allum too ſoon, not giving time for the nitre or ſlam to ſink to the bottom, and thus they are mixed with the allum; and tho' a double quantity is produced, yet as it is foul, it is conſumed in the waſhing: When the liquor hath ſtood four days in the cooler, then that called *Mothers* is ſcooped into a ciſtern, the allum remaining on the ſides and at the bottom, and from thence the *Mothers* are pumped back into the boiler again, till it evaporate, or turn into allum and ſlam; the allum taken from the ſides and bottom of the cooler is put into a ciſtern, and waſhed with water that hath been uſed for the ſame purpoſe, being about 12 pound weight; after which it is roached in the following manner; after waſhing, it is put into another pan with a quantity of water, where it melts and boils a little; then it is ſcooped into a great caſk, where it commonly ſtands 10 days, and it is then fit for the market: The liquors are weighed by *Troy* weight; ſo that half a pint of liquor muſt weigh more than ſo much water, by ſo many penny weights.

Green Copperas Works; *by Mr.* Dan. Colwal. Phil. Tranſ. N° 142. p. 1056.

COpperas ſtones, which ſome call gold ſtones, are found on the ſea-ſhore in *Eſſex*, *Hampſhire*, and ſo weſtward; there are great quantities on the cliffs, but not ſo good as thoſe on the ſhore, where the tide ebbs and flows over them; the beſt are of a bright ſhining ſilver colour, the next are of a ruſty deep yellow, the worſt have gravel and dirt in them of a darker umber colour; ſometimes in the heart of theſe ſtones are found the ſhells of cockles and other ſmall ſhell-fiſh, as alſo ſmall pieces of the planks of ſhips and of ſea-coal.

In order to make copperas, they plot out beds according to the ground; thoſe at *Deptford* are about 100 foot long, 15 foot broad at top, and 12 foot deep, ſhelving all the way to the bottom; they firſt ram the beds very well with ſtrong clay, and then with chalk rubbiſh, whereby the liquor, which drains from the ſolution of the ſtones, is conveyed into a wooden ſhallow trough laid in the middle of the bed, and covered with a board, being alſo boarded on all ſides, and laid lower at one end than the other, whereby the liquor is conveyed into a ciſtern under the boiling houſe; when the beds are tolerably well dried, the ſtones are laid about two foot thick; theſe ſtones take five or ſix years before they yield any conſiderable quantity of liquor, and what they yield before that time is but weak; they ripen by the ſun and rain; yet experience proves, that watering the ſtones, tho' with water prepared by lying in the ſun, and poured on thro' the very ſmall holes of a watering-pot, doth retard the work; in time, theſe ſtones turn into a kind of vitriolic earth, which will ſwell and ferment like leavened dough; when the bed is come to perfection, then once in four years they refreſh it, by laying new ſtones a-top; when they make a new bed, they take a good quantity of the old fermented earth, and mix it with freſh ſtones, and thereby the work is promoted; thus the old earth never becomes uſeleſs: The ciſtern above-mentioned is made of ſtrong oaken boards well joined and caulked; that at *Deptford* will contain 700 tuns of liquor; great care is to be taken that the liquor drain not thro' the beds, or out of the ciſtern; the beſt way to prevent it, is to divide the ciſtern in the middle with oaken boards caulked as before, and thus any one of them may be mended in caſe of any defect; the more rain falls, the more but the weaker will be the liquor, the goodneſs of which is tried by weights prepared for that purpoſe, 14 penny weight is rich; or by putting an egg into the liquor, for the higher it ſwims therein, the ſtronger is the liquor, and ſometimes it will ſwim near half above the liquor; for a minute after the egg is put in, the ambient liquor will boil and froth; and in three minutes time, the ſhell will be quite worn off; a drop of this liquor falling on manufactures of hemp, flax, or cotton, will preſently burn a hole in them, as alſo in woollen and leather.

The liquor is pumped out of the above ciſtern into a boiler of lead about eight foot ſquare, containing about twelve tuns, which is thus ordered; firſt they lay long pieces of caſt iron twelve inches ſquare, as long as the breadth of the boiler, and at the diſtance of twelve inches from each other, and twenty four inches above the fire; then they lay croſs-wiſe ordinary flat iron bars, as cloſe as they can lie, the ſides being made up with brick work; in the middle of the bottom of this boiler is laid a trough of lead, wherein at firſt is put a hundred pound weight of old iron: The fuel for boiling is *Newcaſtle* coal; by degrees they put into the boiling more iron, amounting in all to fifteen hundred pound weight in a boiling; as the liquor waſtes in boiling they pump in freſh liquor into the boiler, whereby, and by a defect in ordering the fire, they were wont to be 20 days before it was enough, which they try by taking up a ſmall quantity of liquor into a ſhallow earthen pan, and obſerving how ſoon it will gather and cruſt about its ſides; but by the ingenious contrivance of Sir *Nicolas Criſp* the work is much facilitated; for at his work at *Deptford* they boil off three boilers of ordinary liquor in one week; which is done, firſt by ordering the furnace ſo, as that the heat is conveyed to all parts of the bottom and ſides of the furnace; again, whereas they were wont to pump cold liquor into the boiler, to ſupply the waſte in boiling, by which means the boiler was checked ſometimes for ten hours, Sir *Nicolas* had a veſſel of lead called a heater placed at the end of the boiler, and a little higher, ſupported by bars of iron as above, and filled with liquor, which, by a conveyance of heat from the furnace was kept near boiling hot, and thus it continually ſupplied the waſte of the boiler, without hindering its boiling; thirdly, by putting due proportions of iron from time to time into the boiler; for as ſoon as they perceive the liquor to boil ſlowly they put in more iron, which will ſoon quicken it; beſides, if they do not continually ſupply the boiling liquor with iron, the copperas will gather to the bottom of the boiler, and melt it, and it will do ſo if the liquor be not preſently drawn off from the boiler into a cooler, as ſoon as it is enough: The cooler is oblong, 20 foot long, nine foot over at the top, five foot deep, tapering towards the bottom, made of tarraſs; into this they let the liquor run, as often as it is boiled enough; the copperas will be 14 or 15 days a gathering or ſhooting, and as much on the ſides as in the bottom, *viz.* above five inches thick; ſome put buſhes into the cooler, about which the copperas will gather, but at *Deptford* they uſe none; that which ſticks to the ſides and to the buſhes is of a bright green, that in the bottom is of a foul and dirty colour; at the end of 14 days they convey the liquor into another cooler, and reſerve it to be boiled a-new with freſh liquor; they ſhovel the copperas on an adjoining floor, ſo that the liquor may drain from it into a cooler: The ſteam which comes from the boiling, is of an acrimonious ſmell: Copperas may be boiled without iron but with difficulty, and without it the boiler will be in danger of melting: Sometimes in ſtirring the earth upon the beds, they find pieces of copperas produced by lying in the ſun.

Salt-ſprings *and* Salt *making at* Droitwich *in* Worceſterſhire; *by Dr.* Tho. Raſtel. Phil. Tranſ. N° 142. p. 1059.

THE country is not quite plain, nor has it any great hills, only ſeveral ſmall eminencies; the greateſt hills are *Lichie* within ſix miles, which ſome call *Lookhigh*, ſuppoſing it to be the higheſt ground in theſe parts, becauſe the ſprings which riſe there run both northward and ſouthward; near theſe are *Clent-hills* about the ſame diſtance; on the other ſide the *Severn* are *Aberly-hills*, at about ſeven miles diſtance; there are many ſalt-ſprings about the town, which is ſeated by a brook-ſide, called *Salwarp-brook*, riſing both in the brook and in the adjacent ground, tho' there are but three pits uſed; where the ſprings are ſalteſt nothing at all grows, but by the brackiſh ditches there grows *Aſter Atticus* or ſtar-wort with a pale flower: Some of the ſalt-ſprings riſe on the top of the ground, and theſe are not ſo ſalt as others; the great pit called *Upwich-pit* is three foot deep, and in it are three diſtinct ſprings riſing in the bottom; one comes into the pit north-weſt, another north-eaſt, the third ſouth-eaſt, which is the richeſt both in quantity and quality; they all differ in ſaltneſs; the pit is about 10 foot ſquare; the ſides are made with ſquare elms jointed in at the full length, which is ſuppoſed to be occaſioned by the ſaltneſs of the ground that ſeems to have been a bog; for digging to try the foundation of a *Seal*, the name of their ſalt-houſes, a long ſtaff was thruſt up to the head; the ſurface of the pit is made of aſhes: Tho' the brine be colder than other water, yet it never freezes; but the rain-water which lies upon the brine, in the extreme hard froſts will freeze a little. The ſoil on the lower ſide of the town is a black rich earth, under which at two or three foot is a ſtiff gravelly clay, then marle; thoſe who make wells for freſh water, if they find ſprings in the marle, they are generally freſh; but if they ſink thro' the marle, they come to a whitiſh clay mixed with gravel, in which the ſprings are more or leſs brackiſh: In the great pit at *Upwich* they have at once three ſorts of brine, which they call by the names of *Firſt-man*, *Middle-man* and *Laſt-man*, and they are of a different ſtrength; the brine is drawn by pumps, ſo that that in the bottom is firſt pumped up, and called the *Firſt-man*; by filling a quart which held 24 ounces, troy of diſtilled water with the firſt brine, beſides the tare of the quart, it weighed 29 ounces, and made ſeven ounces and three drachms of ſalt without any addition; next day the ſame ſalt weighed ſeven ounces ſix drachms; ſo that four tuns of brine make above one tun of ſalt: The ſame quart filled with *Middle-man*, which is the ſecond ſort of brine, weighed 28 ounces; alſo a quart of brine, as it immediately came out of the ſprings weighed 28 ounces, and the third ſort 27 ounces; ſo that what the firſt gains, the laſt loſes, which precipitates as much in 24 hours, as if it ſtood a much longer time: The quantity of brine this pit yields every 24 hours will make 450 buſhels of ſalt, which is drawn out two or three times a day.

In the beſt pit at *Netherwich*, a quart of brine weighs 28 ½ ounces, it is 18 foot deep and four foot broad, and yields as much brine every 24 hours as makes 40 buſhels of ſalt; there is but one ſpring in the pit, which comes in two foot eight inches above the bottom; the worſt pit at *Netherwich* is of the ſame breadth and depth as the preceeding, and a quart of its brine weighs 27 ounces, and yields as much brine as makes about 30 buſhels of ſalt; in this pit are three ſprings, two in the bottom, and one about two foot higher; theſe pits are within ſix yards of each other, and near the brook; the great pit is on the north-ſide; and on the ſouth-ſide about a quarter of a mile lower are the two leſſer pits; in the great pit there is no variation either in the quality or ſtrength of the brine, but the ſprings in the other pits are augmented by much rain and yield leſs ſalt: The brine is divided into *Phats Wallings* that every one may know his own proportion; a *Phat Walling* is divided into 12 *weaker Brines*; and every *weaker Brine* is divided into eight *Burdens*, every burden being a veſſel which contains about 32 gallons; whereof every one hath ſix burdens of *Firſt-man*, ſix of *Middle-man*, and ſix of *Laſt-man*; ſo that every one hath not only his juſt proportion in quantity, but alſo in quality: This brine is carried in coolers to every man's ſeal by eight ſworn men, called *Maſters* of the *Beachin*, and four *Middlemen*, and there put into great tuns for uſe: The fuel formerly uſed was all wood, but ſince that hath been deſtroyed by the iron-works, they generally uſe pit-coal carried 13 or 14 miles by land: The phats in which the brine is boiled are of lead, caſt into a flat plate five ½ foot long and three over; and then the ſides and ends are beaten up, and a little raiſed in the middle, and ſet upon brick work, called ovens, wherein is a grate to make the fire on, and an aſh-hole, called a *Trunk*; in ſome ſeals are ſix of theſe pans, in ſome five, down to 4, 3, 2; in each of theſe pans is boiled at once as much brine as makes three pecks of white ſalt, called a *Lade*; and it is laded out of the pan with a loot, and put into barrows, which are ſet into *Baſtals* over veſſels called *Leach-combs*, that the brine called *Leach* may run from the ſalt, with which they dreſs their phats, when the cold brine, they are firſt filled with, is a little boiled away; in theſe *Baſtals* the ſalt ſtands till it is dry, which is in about four hours, then it is carried into *Cribs*, which are houſes boarded on the bottom and ſides, where it is kept till ſold, which is ſometimes half a year, or three quarters; in which time if the *Crib* be good, it will not waſte a twelfth part, the ſalt itſelf being of ſo ſtrong a body; whereas in *Cheſhire* they are forced to keep their ſalt on barrows in ſtoves to dry, and to make it no faſter than they ſell.

For clarifying the brine nothing elſe is uſed but whites of eggs; a quarter of a white of an egg is put into a gallon or two of brine, which, being beaten with one's hand, lathers like ſoap; a ſmall quantity of this froth put into each phat raiſes all the ſcum, ſo that the white of one egg will clarify 20 buſhels of ſalt; and by this means the ſalt is very white, and it has no ill ſavour, as that clarified with blood.

They uſe nothing at all to make it granulate; for the brine is naturally ſo ſtrong, that, unleſs it be often ſtirred, it will make ſalt as big grained as bay-ſalt; and brine has been boiled to a conſiſtence of candy, and clods of ſalt as clear as the cleareſt alum have been produced, reſembling iſle of *May* ſalt; ſo that they are obliged to put a ſmall quantity of roſin into the brine, to make the grain of the ſalt ſmall.

Beſides the white ſalt, there is another ſort called clod-ſalt, growing to the bottom of the phats, which, after the white ſalt is laded out, is dug up with a picker, made like a maſon's trowel, pointed with ſteel, and fix'd on a ſhort ſtaff; this is the ſtrongeſt ſalt, and moſt uſed for ſalting bacon and neats tongues; it makes the bacon redder than other ſalt, and the fat eat more firm; if the ſwine are fed with beach maſt, it hardens the fat almoſt as much as if fed with peaſe, and ſalted with white ſalt; it is much uſed by country-women in their runnet-pots, and they reckon it better for their cheeſe; theſe clods are uſed to broil meat with, laying them on coals; it is accounted too ſtrong for ſalting beef, as depriving it of too much of its ſweetneſs.

There is a third ſort of ſalt called *Knockings*, which candies on the ſtails of the barrows, as the brine runs from the ſalt, after it is laded out of the phats; this ſalt is much uſed for the ſame purpoſes as the clod-ſalt, tho' it be not altogether ſo ſtrong.

There is a fourth ſort called *Scrapings*, which is coarſe and mixed with droſs and duſt, and ſcraped off the phats when they reach them, that is, when they take their phats off the fires to beat up the bottom, and it is bought by the poorer ſort to ſalt meat with.

A fifth ſort is *Pigeon-ſalt*, which is nothing but the brine running out thro' the crack of a phat, and hardening to a clod on the outſide over the fire.

Laſtly, the *Salt-loaves* are the fineſt of the white ſalt, whoſe grain is made ſomething finer than ordinary, that it may the better adhere together; which is done by adding a little more roſin, and beating it into the barrows when laded out of the phat.

At *Droitwich* they uſe no iron-pans as in *Cheſhire* and other places; for it has been found upon trials that the ſtrength of the brine doth ſo corrode, that it quickly wears out thoſe of forged iron, and breaks thoſe of caſt iron.

This *Droitwich-ſalt* is not ſo apt to diſſolve as *Cheſhire* ſalt, nor as that which is made by diſſolving bay-ſalt, and clarifying it, called ſalt upon ſalt, which appears by its keeping long without fire: No ſalt can be whiter than it, and conſequently none freer of droſs; it is alſo the heavieſt ſalt, a *Wincheſter* buſhel of it weighing half a hundred weight: In the time of the firſt *Dutch* war this ſalt was carried to the weſt, where before they only uſed foreign ſalt; upon firſt uſing it they complained it made their meat too ſalt, which was owing to their putting to it the ſame quantity as of other ordinary ſalt.

The Culture of Maize *by Mr.* Winthorp. Phil. Tranſ. N° 142. p. 1065.

THE corn uſed in *New England* before the *Engliſh* planted there, was called by the natives *Weachin*, and known by the name of *Maize* in ſome ſouthern parts of *America*;

America; the ear is generally about a ſpan long, conſiſting of ſeveral rows of grain, commonly eight or more, according to the goodneſs of the ſoil, and in each row are uſually upwards of 30 grains; it is of various colours, as red, white, yellow, blue, olive, greeniſh, black, ſpeckled, ſtriped, *&c.* ſometimes in the ſame field and the ſame ear; but the white and yellow are the moſt common: The ear is clothed and armed with ſeveral ſtrong thick huſks, not only defending it from the night-colds, it being the latter end of *September* before it be fully ripe in ſome parts, and from unſeaſonable rains, but alſo from crows, ſtarlings and other birds: Its ſtalk grows to the height of ſix or eight feet more or leſs according to the condition of the ſoil or the kind of the ſeed; the *Virginian Maize* grows taller than that of *New England*; and there is another ſort uſed by the northern *Indians* farther up the country growing much ſhorter than that of *New England*; it is always jointed like a cane, and full of ſweet juice, like the ſugar-cane; and a ſyrup as ſweet as ſugar may be made of it, as hath been often tried; and whatever is ſweetned therewith could not be diſtinguiſhed from the like ſweetened with ſugar; at every joint are long leaves almoſt like flags, and at the top a bunch of flowers, like the bloſſoms of rye: It is planted between the middle of *March* and beginning of *June*, but moſt commonly from the middle of *April* to the middle of *May*: In the moſt northerly parts, they have a peculiar kind called *Mohauks-corn*, which tho' planted in *June*, will be ripe in ſeaſon; the ſtalks of this ſpecies are ſhorter, and the ears grow near the bottom of the ſtalks, and are generally of divers colours: The manner of planting it is in rows at equal diſtances every way, about five or ſix feet: They open the earth with a hoe, taking away the ſurface three or four inches deep, and the breadth of the hoe, and ſo throw in four or five grains at a little diſtance from each other, which they cover with earth; if two or three grow they may do well, for ſome of them are uſually deſtroyed by birds or mouſe-ſquirrels: When the corn is grown up an hand's length, they cut up the weeds and looſen the earth about it with a broad hoe, repeating this labour as the weeds grow; when the ſtalk begins to grow high, they draw a little earth about it, and upon the putting forth of the ear, as much earth as will make a little hill, like a hop-hill; after this they give themſelves no other trouble about it till harveſt: After it is gathered, it muſt, unleſs laid very thin, be preſently ſtripped of the huſks, otherwiſe it will heat, grow mouldy, and ſometimes

times ſhoot; the common way, which they call tracing, is to weave the ears together in long traces by ſome parts of the huſks left thereon; theſe traces they hang upon ſtages, or other bearers either within or without doors; for hung in that manner, they will keep good and ſweet all the winter after, tho' expoſed to all weathers: The natives commonly threſh it as they gather it, dry it well on mats in the ſun, and then diſpoſe of it in holes in the ground, which are their barns, well lined with withered graſs and mats, and then covered with the ſame and over all with earth, and thus it keeps very well for uſe: The *Engliſh* have now taken to a better way of planting, with the plow making ſingle furrows thro' the whole field at about the diſtance of ſix feet, or as they ſee convenient, and to theſe they make croſs furrows at the ſame diſtance; where they meet they throw in the corn, and cover it either with the hoe or by running another furrow with the plow: When the weeds begin to over top the corn, then they plough over the reſt of the field between the planted furrows, and ſo turn in the weeds; this is repeated where they begin to hill the corn with the hoe, and thus the ground is better looſened than with the hoe, and the roots of the corn have more liberty to ſpread; where any weeds eſcape the plough they uſe the hoe: Where the ground is bad and worn out, the *Indians* uſed to put two or three of the fiſh called *Aloofes* under or near each corn hill, where they have had many times a crop double what the ground would have otherwiſe produced: After the crop is off, the fields are almoſt as well fitted for *Engliſh* corn, eſpecially ſummer-grain, as peaſon or ſummer-wheat, as if lying fallow, they had had a very good ſummer tilth: The *Indians* as alſo ſome *Engliſh*, eſpecially in good ground, and which is well fiſhed, plant at every corn-hill a kind of *French* or *Turkey* beans, the ſtalks of the corn ſerving inſtead of poles for the beans to climb up by; and in the vacant places between the hills, they plant ſquaſhes and pompions; and many, after the laſt weeding, ſprinkle turnip-ſeed between the hills, and thus after harveſt they have a good crop of turneps; the ſtalks of this corn cut up before it is too dry and ſo laid up, are good winter fodder for cattle; but they uſually leave them on the fields for them to feed on; the huſks alſo about the ear are good fodder; the *Indian* women ſlit them in narrow ſlips and weave them artificially into baſkets of ſeveral faſhions: The *Indians* dreſs this corn for food ſeveral ways, ſometimes boiling it whole, till it ſwell and become tender, and ſo either eating it alone, or with their fiſh and veniſon inſtead of bread; ſometimes bruiſing it in mortars, and ſo boiling it; but commonly they parch it in the embers, ſo artfully ſtirring it, as without burning to be very tender, turned almoſt inſide out, and alſo become white and mealy: this they ſift well from the aſhes, and beat it into meal in wooden mortars with a long ſtone for a peſtle; this is their conſtant food at home; and frequently when they travel, they put it up in a bag, and thus at all times it is ready for eating, either dry or mixed with water, and they find it very wholeſome food: The *Indians* have another ſort of proviſion from this corn, which they call ſweet corn; when the corn in the ear is full and ſtill green, it hath a very ſweet taſte; this they gather, boil and dry, and ſo put it up into bags or baſkets for uſe; boiling it again either whole or groſly beaten, when they eat it either alone or with fiſh, veniſon, beaver, or other fleſh, accounting it a choice diſh: They ſometimes roaſt theſe green and ſweet ears before the fire or in the embers, and ſo eat the corn; by which means they have a ſufficient ſupply of food tho' their old ſtore be exhauſted: The *Engliſh* make very good bread of the full ripe ground corn; but it is not ordered as other corn; for if it be mixed into ſtiff paſte it will not be ſo good, as if made only a little ſtiffer than for puddings, and ſo baked in a very hot oven, ſtanding therein either all day or all night; but becauſe upon the firſt pouring of it on the oven floor, it ſpreads abroad, they pour a ſecond layer or heap on every firſt, and thereby make ſo many loaves, which if ſufficiently baked and good, will be of a deep yellowiſh colour, if otherwiſe, it will be white: It is alſo ſometimes mixed with half or a third part of rye or wheat-meal, and ſo with leaven or yeaſt it is made into loaves of very good bread: Before they had mills, when they had watered and huſked the corn, and beaten it in wooden mortars, they boiled to a thick batter the coarſer part ſifted from the meal and ſeparated from the looſe hulls by the wind; to which when cold they added ſo much of the fine meal as would ſerve to ſtiffen it into a paſte, of which they made very good bread: The beſt ſort of food made of this corn by the *Engliſh* is a diſh called *Samp*; after firſt watering it for half an hour and beating it in a mortar, or elſe grinding it in a hand or other mill into the bigneſs of rice, they next ſift the flour, and winnow the hulls from it; then they boil it gently till it be tender, and ſo with milk or butter and ſugar, they make it into a very pleaſant and wholeſome diſh: This was the moſt uſual fare of the firſt planters in theſe parts; and the *Indians* that feed much on this corn are ſeldom known to have the ſtone.

The *Engliſh* have found out a way of making very good beer of this grain, that is, either of the bread made thereof, or elſe by malting it; the way of making beer of bread, is to break and cut it into great lumps as big as a man's fiſt, and then maſh it, and proceed with it as with malt and its impregnated liquor, wort, either adding or omitting hops at pleaſure: To make good malt of this corn, a particular way muſt be taken; the barley malt-maſters have uſed all their ſkill to make good malt of it the ordinary way, but to no effect; for it is found by experience, that this corn, before it be fully malted, muſt ſpire out at both ends, that is, both at root and blade to a great length; for which end it muſt be laid upon a heap a convenient time; wherein on one hand, if it lie of a ſufficient thickneſs for coming, it will quickly heat and mold, and the tender ſpires be ſo entangled, that the leaſt opening of the heap breaks them off, and ſo hinders the further maturation of the grain into malt; on the other hand, if it be ſtirred and opened to prevent too much heating, the ſpires which have begun to ſhoot, ceaſe growing, and conſequently the corn again ceaſes to be promoted to the mellowneſs of malt: To avoid all theſe difficulties, the following method was tried and found effectual; take away the ſurface of the earth in a garden or field two or three inches, throwing it up half one way and half the other; then lay the corn for malt all over the ground, and cover it with the earth that was pared off, and then you have no more to do, till you ſee the whole plot of ground like a green field, covered over with the blades of corn, which will be in ten days or a fortnight, according to the ſeaſon of the year; then take it up, and ſhake the earth from it, and dry it; for the roots will be ſo entangled together, that it may be taken up in great pieces; to make it very clean it may be waſhed, and then preſently dried on a kiln, or in the ſun, or ſpread thin on the malting floor: And in this manner, every grain that is good will grow and be mellow, mealy, and very ſweet; and the beer made of it, will be wholeſome, pleaſant, and of a good brown colour; yet beer made of the bread as above-mentioned, is as well coloured, as wholeſome and pleaſant, and more durable; and this is what they chiefly uſe.

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The making of Malt; *by Sir* Robert Moray. Phil. Tranſ. N° 142. p. 1069.

MALT is made in *Scotland* of no other grain than barley, of which there are two kinds; one with four rows of grains on the ear, the other with two; the former is the more commonly uſed, but the latter makes the beſt malt: The more recently barley hath been threſhed, it makes the better malt; but if it has been threſhed ſix weeks, or upwards, it does not make good malt, unleſs it be kept in one equal temper; whereof it eaſily fails, eſpecially if kept up againſt a wall, for that which lies in the middle of the heap is freſheſt, that on the outſides and top is over dry, and that next the wall ſhoots, and that at bottom rots; ſo that ſome grains do not come well, as they call it, that is, they never attain to that right mellow temper, malt ſhould have, and thus they ſpoil all the reſt; and ſome grains come well, ſome not at all, ſome half, and ſome too much; the beſt way to preſerve threſhed barley long in good temper is not to ſeparate the chaff from it; but as long as it is unthreſhed, it is always good: Brewers uſe to keep their barley in large rooms on boarded floors, laid about a foot deep, and turned at intervals with ſhovels: Barley that has been overheated in the ſtacks or barns before it be ſeparated from the ſtraw, will never prove good for malt, nor any other uſe; but tho' it heat a little after it is threſhed and kept in the chaff, it will not be the worſe, but rather the better for it; for then it will come the ſooner, and more equally; a mixture of barley that grows on ſeveral grounds, never proves good malt, becauſe it comes not equally; ſo that the beſt barley to make malt of, is that which grows in one field, and is kept and threſhed together: Take then good barley newly threſhed, and well purged from the chaff, and put eight bolls of it, that is, about ſix *Engliſh* quarters, into a ſtone trough; where let it infuſe till the water be of a bright reddiſh colour, which will be in about three days, more or fewer, according to the moiſtneſs or dryneſs, ſmallneſs or bigneſs of the grain, and according to the ſeaſon of the year or temper of the weather; in ſummer malt never makes well; in winter it will require a longer infuſion than in ſpring or autumn: One may know when it is ſufficiently ſteeped by other marks than the colour of the water; as the exceſſive ſwelling of the grain, or its too great ſoftneſs when over ſteeped; being, when in the right temper, like that barley prepared to make broth of; when the barley is ſufficiently ſteeped, take it out of the trough, and lay it on heaps, and ſo let the water drain from it; then in two or three hours turn it over with a ſhovel, and lay it in a new heap about 20 or 24 inches deep; and this they call the coming heap, and in the right managing of this heap lies the greateſt ſkill; and in this heap it will lie 40 hours, more or fewer, according to the fore-mentioned qualities of the grain, *&c.* before it come to the right temper of malt; whilſt it lies in this heap, it is to be carefully looked to after the firſt 15 or 16 hours; for about that time the grain will begin to put forth the root, which when they have equally and fully done, the malt muſt within an hour after be turned over with a ſhovel, otherwiſe the grains will begin to put forth the blade or ſpire alſo, which by all means muſt be prevented; for hereby the malt will be utterly ſpoiled, both as to its pleaſantneſs of taſte and its ſtrength; if all the malt ſhould not come equally, becauſe that which lies in the middle being warmeſt will uſually come firſt, let it be turned over, that the outmoſt malt may lie inmoſt, and ſo leave it till all come alike: As ſoon as the malt is ſufficiently come, turn it over, and ſpread it to a depth not exceeding five or ſix inches, and by the time it is all ſpread out, turn it over and over three or four times, after this turn it once in four or five hours, making the heap thicker by degrees, and continuing to do ſo conſtantly for the ſpace of 48 hours at leaſt; this frequent turning it, cools, dries, and deadens the grain, whereby it becomes mellow, melts eaſily in brewing, and then ſeparates entirely from the huſk; after which throw up the malt into a heap, as high as you can; where let it lie till it grow as hot as your hand can bear it, which uſually happens in about 30 hours; and this compleats the ſweetneſs and mellowneſs of the malt; after the malt is ſufficiently heated, ſpread it to cool, and turn it over again in ſix or eight hours after; then dry it upon a kiln, and after one fire, which muſt ſerve for 24 hours, give it another more ſlow, and a third if needful; for if the malt be not thoroughly dried, it cannot be well ground, neither will it diſſolve well in the brewing, and the ale it makes will be red, bitter, and will not keep: The beſt fuel is peat, the next charcoal made of pit-coal or cinders, heath, broom, and furzes are naught; if there be not enough of one kind, burn the beſt firſt, for that gives the ſtrongeſt impreſſion as to the taſte.

Obſer-

Obſervations on the Animalcula *in the* Semen *of* Animals; *by M.* Leewenhoeck. Philoſophical Collections N° 1. p. 3.

M. *Leewenhoeck* upon viewing the milt of a live codfiſh, found the juice that run from it full of exceeding ſmall living animals inceſſantly moving to and fro; he obſerved the ſame thing in the milts of pikes or jacks, and he judged there were at leaſt 10000 of theſe animals in the quantity of a grain of ſand; and theſe were ſmaller than thoſe he obſerved in beaſts, but their tails were longer and thinner; he found the matter in the *Vaſa Deferentia* of a male hare, four days after it was killed, exceeding full of theſe ſmall animals, reſembling tadpoles ſwimming in a clear liquor, but without motion; he alſo obſerved innumerable animals in the *Semen* of a cock, which had been kept alone in a coop for five days, at leaſt 50000 in the bulk of a ſand; theſe were like river-eels, and they wriggled much: The almoſt incredible number of theſe animals will appear from the following calculation; M. *Leewenhoeck* ſuppoſed, that in a quantity of the juice of the milt of a male codfiſh of the bigneſs of a ſmall ſand, there are contained more than 10000 *Animalcula* with long tails; and conſidering how many ſuch quantities of the bigneſs of a ſand might be contained in the whole milt; he was of opinion, that the milt of one ſingle codfiſh contained more living animals than there were men living, at once, upon the face of the earth; for he ſuppoſes, that 100 ſands in length will make an inch, therefore in a cubic inch there will be a million of ſuch ſands; and he found the milt of a codfiſh to be about 15 cubic inches, it muſt therefore contain 15 millions of quantities as big as a ſand; now if there be 10000 animals in each of thoſe quantities, there will be in the whole 150000000000; now to calculate the number of men upon the face of the earth at once, there are in a great circle 5400 *Dutch* miles, whence he collects the ſurface of the earth to be 9276218 ſquare *Dutch* miles, and ſuppoſing one third of the whole to be dry land, which is 3092072, and two thirds of this latter, *viz.* 2061382 to be inhabited, and further ſuppoſing *Holland* and *Weſt-Friezland* to be 22 miles long, and 7 broad, which make 154 ſquare miles, the habitable part of the world does therefore exceed *Holland* and *Weſt-Friezland* by 13385; now if the number of people in *Holland* and *Weſt-Frizeland* be about a million, and if all the reſt of the habitable parts of the world be as populous as theſe, which is very unlikely, there would be thirteen thouſand, three hundred, eighty-five millions of men at once upon the face of the whole earth; but in the milt of the codfiſh there were one hundred and fifty thouſand millions of animals, the number of theſe therefore will exceed the number of men by more than ten times.

Of Fiery Damps *in Mines; by Mr.* J. Beaumont. Phil. Collect. N° 1. p. 6.

ABOUT two miles on the ſouth-eaſt of ſtony *Eaſton*, at a place which nearly borders on *Mendip* hills, there begins a running of coal, conſiſting of ſeveral veins, which extends itſelf eaſtward about four miles; there is much working in this running, and fire-damps continually happen there, ſo that many have been killed, others maimed, and ſeveral burnt; ſome have been blown up at the works mouth, and the *Turn-beam*, which hangs over the ſhaft, has been thrown off its frame: The middle and more eaſterly parts of this running are ſo very ſubject to thoſe fiery damps, that there is ſcarce a pit without them; to prevent miſchief, the colliers keep their air very quick, and they uſe no candles in their works, but of a ſingle wick, and thoſe of 60 or 70 to the pound, which notwithſtanding give as great a light there, as others of 10 or 12 to the pound in other places, and they always place them behind them, and never preſent them to the breaſt of the work: When any one is burnt, their uſual method of cure is this; they preſently betake themſelves to a good fire, firſt bathing the burnt parts with hot cow's milk, after which they uſe an ointment proper for burnings.

Theſe works are apt to take fire all the year round, and they will readily do it at any time, if a candle be carried within that air; but generally, and with greateſt violence in winter, and chiefly in a black froſt, when the air runs beſt; the danger of firing is alike both in wet and dry grounds; but there are no fumes from the mouth of any ſhaft, which can be lighted by a candle or torch: The damps lie as well towards the bottom or ſole of the work, as towards the roof, it being nothing but an inviſible ſulphureous vapour expanded thro' the whole work: There is not at the mouth of any ſhaft any unuſual wind or current of vapours which comes from beneath; in wet works there are often bubbles on the ſurface of water ſtanding there, which will preſently take fire, if a candle be held to them.

The over-flowing of ſome Rivers *in* Gaſcoign. Phil. Collect. N° 1. p. 9.

IN the beginning of *July* 1678, after ſome gentle rains, which had not ſwelled the waters of the *Garonne* more than uſual, this river ſwelled in one night to ſuch a degree as to carry away with it all the bridges and mills above *Tholouſe*; in the plains below this town ſome of the inhabitants were drowned, together with their cattle, others ſaved themſelves by climbing up trees, and getting to the tops of houſes: At the ſame time exactly, the two rivers of *Adour* and *Gaue*, which fall from the *Pyrenees* as well as the *Garonne* and ſome other ſmall rivers of *Gaſcoign*, which have their ſource in the plain, overflowed in the ſame manner, and cauſed the ſame devaſtations: The inhabitants of the lower *Pyrenees* obſerved that the water ran with violence from the entrails of the mountains, about which there were opened ſeveral channels, which forming ſo many impetuous torrents tore up the trees, the earth, and great rocks in narrow places, where they found not a paſſage large enough; the water alſo which ſpouted from all the ſides of the mountain in innumerable jets, all the time of the greateſt overflowing, had the taſte of minerals; in ſome of theſe paſſages the waters ſtunk, and had a pungent quality; ſo that the ſubterraneous waters ſeem to be the true cauſe of this overflowing, which paſſing from the bowels of the earth thro' divers channels, had contracted that ſtench and pungency.

9

An Account of Flying; *by Dr.* Hook. Phil. Collect. N° 1. p. 14.

THE art of flying hath been attempted by ſeveral in all ages, particularly in the time of friar *Bacon*, who not only affirms the art poſſible, but aſſures us, he himſelf knew how to make an engine, wherein a man ſitting, might be able to convey himſelf thro' the air like a bird; and affirms, that there was then another perſon who had actually tried it with good ſucceſs; and Dr. *Hook* informs us, that one Mr. *Gaſcoigne* had alſo tried it, but he dying, the thing died with him.

The ſieur *Beſnier*, a ſmith of *Sable* in the county of *Maine*, had invented an engine for flying; it conſiſted of two poles or rods, with an oblong *Chaſſie* or wing of taffety at each end, which *Chaſſies* fold from above downwards, like the frame of a folding window; the operator ſits the poles upon his ſhoulders, ſo that two of the *Chaſſies* may be before him, and the other two behind him; the order of moving them is this; when the right hand ſtrikes down the right wing A before, Fig. 1. Plate V. the left leg, by means of the ſtring E, pulls down the left wing B behind; then immediately after, the left hand moves or ſtrikes downwards the left wing C before; and at the ſame time the right foot by the ſtring F, moves or pulls down the right wing D behind, and thus ſucceſſively and alternately; the diagonally oppoſite wings always moving downwards, or ſtriking the air at once: Two things ſeem to be wanting to this machine; firſt, a ſubſtance that ſhall be exceeding light, and yet of great extenſion, and which applied to any part of the body, it ſhall be able to ſuſpend it in the air; the ſecond is the fitting and adjuſting of a tail, both to ſupport and ſteer the flier, and it ſeems to be very difficult to give the neceſſary motions and directions to ſuch a tail.

Of a Flying Ship; *by* Fr. Lana. Phil. Collect. N° 1. p. 18.

FRanciſco *Lana*, finding that air is to water as 1 to 640, concludes, that if a veſſel of glaſs or other matter could be made that ſhould weigh leſs than the air that is in it, and all its air be exhauſted, this veſſel would be ſpecifically lighter than air itſelf, and would ſwim in it, and aſcend on high; and this he ſuppoſes may be done, by making a round veſſel of thin plate-braſs, weighing 3 ounces in a ſquare foot, and 14 foot in diameter; for the ſurface of the veſſel will be 616 ſquare feet, and the braſs will weigh no more than 1848 ounces; whereas its content will be 1437 $\frac{1}{2}$ cubic feet, and that quantity of air will weigh 2255 $\frac{2}{3}$ ounces; ſo that upon evacuating that air, the veſſel will be 307 $\frac{2}{3}$ ounces lighter than air, and therefore will not only aſcend into the air, but alſo carry up with it a weight of 307 $\frac{2}{3}$ ounces; and thus by encreaſing the bulk of the veſſel, without encreaſing the thickneſs of the braſs plates, he ſuppoſes a kind of ſhip may be made to ſwim in the air, and carry two or three men in it.

Dr. *Hook* ſhews the fallacy of this authors reaſoning, when he ſuppoſes copper of 3 ounces in a foot ſquare, to be of ſufficient thickneſs to reſiſt the preſſure of the air in a globe of 14 foot diameter, nay of any dimenſion, which muſt be falſe; for the preſſure from without inwards, tho' it be always the ſame upon equal ſurfaces, yet upon unequal ſurfaces the caſe is quite otherwiſe, for there the preſſure will be found not the ſame, but to encreaſe always in proportion to the ſurface; and conſequently, the thickneſs of the copper or any other metal muſt increaſe in proportion to the diameter of the ſphere, and therefore the weight of the copper muſt always increaſe in the ſame proportion, at leaſt to the ſolidity of the ſphere; ſo that by augmenting the quantity of the ſphere, it is ſo far from being proportionably lighter than air, and proportionably ſtrong, that it is quite the contrary; for it is manifeſt, that a larger ſphere has leſs power of reſiſting the ſame preſſure of the air than a ſmaller, becauſe of the finite reſiſtance of matter to preſſure, there being ſome degree of preſſure that no bodies can reſiſt.

Problems *touching compound* Intereſt *and* Annuities, *reſolved by Mr.* Martindale, *and explained by Mr.* J. Collins. Phil. Collect. N° 1. p. 34.

TWELVE problems in compound intereſt and annuities expreſſed in ſymbols, to be reſolved by logarithms, and diſtinguiſhed into 3 ranks, whoſe ſymbols are thus to be underſtood

p	ſignifies	Principal	common to all the 3 ranks.		
r		Rate, *viz.* 1 *lb.* with its rate			
t		Time			
a		Amount or aggregate	proper to	1	Ranks.
ſ		Sum of principal and arrearages		2	
d		Difference of principal and worth		3	

Their capitals ſtand for the logarithms of the number ſignified by the ſmall letters; D. ſignifies *data*, or what is given; Q. *Quæſitum*, or whas is ſought; Prob. problem; Res. reſolution.

The firſt rank touching compound intereſt for a ſingle ſum of money.

1 Prob. D. p, r, t. Q. a? Res. $R\,t + P = A$.

2 Prob. D. a, r, t. Q. p? Res. $A - R\,t = P$.

3 Prob. D. p, a, t. Q. r? Res. $\frac{A - P}{t} = R$.

4 Prob. D. r, a, p. Q. t? Res. $\frac{A - P}{R} = t$.

The ſecond rank concerning annuities in arrear at compound intereſt, is grounded upon theſe two axioms; 1. The annuity and rate of intereſt being given, the principal correſponding to the annuity is in effect alſo given, being thus eaſily found by the *Rule of Three*; as the intereſt of any principal, *e. gr.* of 1, 10, 100, *&c.* is to that principal; ſo is the annuity or penſion to its principal. 2. The ſum of the principal, and the arrearage of all the payments being found, the arrearages alone may be obtained by ſubſtracting the principal from that ſum: The problems are the following.

1. Prob. D. p, r, t. Q. s? Res. $Rt + P = S$
2. Prob. D. s, r, t. Q. p? Res. $S - Rt = P$
3. Prob. D. p, s, t. Q. r? Res. $\frac{S - P}{t} = R$
4. Prob. D. p, s, r. Q. t? Res. $\frac{S - P}{R} = t$

The third rank touching annuities anticipated, or bought for ready money or an equivalent, at compound intereſt diſcounted, is founded on the former of the two preceeding axioms, and the following; *viz.* if the difference of principal and worth be once found, the worth is eaſily obtained, by ſubſtracting that difference from the principal, which is ever greater, being the worth of the annuity at that rate for ever.

1. Prob. D. p, r, t. Q. d? Res. $P - Rt = D$
2. Prob. D. d, r, t. Q. p? Res. $D + Rt = P$
3. Prob. D. p, d, t. Q. r? Res. $\frac{P - D}{t} = R$
4. Prob. D. p, d, r. Q. t? Res. $\frac{P - D}{R} = t$.

Okey Hole *and ſome other ſubterraneous Caverns in* Mendip-hills; *by Mr.* J. Beaumont. Phil. Collect. N° 2. p. 1.

ON the ſouth-ſide of *Mendip-hills* within a mile of *Wells* is a famous grotto, known by the name of *Okey-hole*, much reſorted to by travellers; the entrance into it is in the declivity of theſe hills, and is environ'd with rocks, having near it a precipice about 10 or 12 fathom deep; at the bottom of which there always iſſues from the rock a conſiderable current of water; the naked rocks above the entrance, ſhew themſelves for about thirty fathom in height, tho' the whole aſcent of the hill above it be about a mile, and very ſteep: As you paſs into this cavern you go upon a level, but advancing further into it, you find the way rocky and uneven, ſometimes aſcending and ſometimes deſcending; the roof in the higheſt part is about eight fathoms from the floor, and in ſome places it is ſo low, that a man muſt ſtoop to paſs thro'; its width is various; in ſome places it is about five or ſix fathoms; in others not above a fathom or two; it extends itſelf in length about 200 yards: At the farther end of this cavern there riſes a large ſtream ſufficient to drive a mill, it runs all along one of its ſides, and at length falls down about ſix or eight fathom between the rocks, and forcing its way thro' the clifts diſcharges itſelf into a valley; within the cavern it is well ſtored with eels and hath ſome trouts in it, which muſt neceſſarily have been engendred here, and were not convey'd thither from any other place, there being ſo great a fall of water near the entrance; in a dry ſummer a great number of frogs are ſeen all along the cavern, and ſeveral other little animals in ſome ſmall ciſterns of water there; before you come to the middle of this cavern you meet with a bed of very fine ſand, much uſed by artificers to caſt metals in; on the roof, at certain places, hang great numbers of bats, as is generally the caſe in all caverns, whoſe entrance is upon a level, or ſomewhat aſcending or deſcending.

About five miles from this, on the ſouth-weſt part of *Mendip-hills*, near a place called *Chedder*, lies another cavern, into which you muſt aſcend about 15 fathoms on the rocks; this cavern is not of ſo large an extent as the former, neither hath it any thing peculiar in it.

Theſe two caverns have no communication with the mines; but it is generally obſerved, that whereever mines of lead ore are, there caverns of various kinds and ſituations are found; the moſt conſiderable in *Mendip-hills* is a cavern in a hill called *Lamb*; there is a deſcent about 10 fathom into a perpendicular ſhaft, then you come into a leading vault, which extends itſelf in length about 40 fathom, it runs not upon a level, but deſcends, ſo that when you come to the end of it, you are 23 fathom deep by a perpendicular line; its floor is full of looſe rocks, its roof is firmly vaulted with lime-ſtone rocks, with flowers of all colours hanging from them, which preſent a moſt beautiful proſpect to the eye, and they are always kept moiſt by the diſtilling waters; in ſome places the roof is about five fathoms in height, in others ſo low, that a man has much ado to creep along; generally its width is three fathoms; this cavern croſſes many veins of ore; about its middle on the eaſt ſide lies a narrow paſſage into another cavern, which runs between 40 and 50 fathom in length: At the end of the firſt cavern there opens another large one about 60 fathom in circumference, 20 in height and about 15 in length: The frequency of theſe caverns on theſe hills may be eaſily gueſſed at, becauſe of the ſwallow-pits which often occur there, and are formed by the falling in of the roofs of caverns; ſome of theſe pits are of a large extent and very deep; and in the bottom of thoſe ſwallows, oaks have been found at the depth of 15 fathom in the earth.

A bu-

A human Body, *after being long buried, almoſt wholly converted into* Hair. Phil. Collect. N° 2. p. 10.

THE body of a woman that had been buried for 43 years in a yellow dry earth, was found covered all over with very thick ſet hair, and ſtill retaining its human ſhape; but upon handling the upper part of the head, the body fell to pieces and left nothing in the hands but a handful of hair, there being neither ſcull nor any other bone to be ſeen, except a very ſmall part of that which was ſuſpected to be the great toe of the right foot; this hair was ſomewhat rough at firſt, but it afterwards grew much harder, and of a brown red colour.

Dr. *Tyſon* obſerves that it is the opinion of the learned *Honoratus Fabri* and others; that hair, wool, feathers, nails, horns, teeth, *&c.* are animal plants; *Petrus Borellus* thinks, that as plants, they may be tranſplanted, and made to grow in a ſoil they did not at firſt; and what he relates concerning teeth being drawn and ſet again, Dr. *Tyſon* affirms to be truth, having tried it on himſelf: Tho' the outward ſurface of the body be the uſual place where hair grows, yet it hath been ſometimes found on the tongue, upon and in the heart, in the breaſt and kidneys, and other glandulous and muſcular parts of the body; but there is ſcarce any internal part more ſubject to it than the *Ovaria* or teſticles of females.

An Experiment concerning the Plague; *by Dr.* Jo. Bapt. Alprunus. Phil. Collect. N° 2. p. 17.

UPON putting the virulent matter of a peſtilential bubo into a retort, and luting a receiver very cloſe to it, and applying ſeveral degrees of fire; at firſt came over a water, then a fat and oily matter, and at laſt a ſalt aſcended into the neck of the retort; the fire being removed and the glaſſes ſeparated, there was emitted a ſtrong fetid ſcent, by which the Doctor was ſtruck with violent tremblings, and to the taſte it was found to have an acrimony as ſtrong as *Aqua Regis*; hence it is no wonder that ſo many are affected with continual vomitings, diarrhoea's, pungent pains in bubo's, and burnings in carbuncles; hence alſo it appears why ſudorifics are the beſt remedies, as they allay the acrimony, and drive it out thro' the pores: In peſtilential caſes Dr. *Alprunus* uſed to make inciſions with a lancet in the right and left *Inguen*, and put in a ſeton; and this he often tried with good ſucceſs, great quantities of matter diſcharging itſelf that way.

An univerſal Preſervative againſt Infection; *by Dr.* Jac. Jo. Wenceſlaus Dobrzenſky de Nigro Ponte. Phil. Collect. N° 2. p. 20.

WHatever perſon viſits patients, if he would preſerve himſelf from infection, muſt be ſure, ſo long as he continues within the ſphere of their ſteams, never to ſwallow his ſpittle, but ſpit it out; for this author is of opinion that ſpittle eaſily imbibes the infection, and that it is a proper vehicle for conveying it into the ſtomach, where it produces its fatal effects; he thinks that moſt diſeaſes, eſpecially peſtilential fevers, are infectious; that this proceeds from a ſeminal ferment, which is emitted by the patient by way of ſteams into the ambient air, and which infects all things within a certain ſphere or diſtance; and this drawn into the mouth by the breath is apt to infect the ſpittle, which, being ſwallowed, infects the ſtomach, and ſo the reſt of the body; but being ſpit out, frees the body from infection; and therefore he conceives that ſubſtances of a ſtrong ſcent and taſte kept in the mouth, and chewed to promote ſpitting, are very proper and neceſſary for phyſicians, ſurgeons and apothecaries, who are obliged to viſit infected perſons.

A double Birth *joined at the* Breaſt. Phil. Collect. N° 2. p. 21.

THESE two infant bodies began to be joined at the navel, each having all its parts below to the very toes diſtinct and ſeparated; upwards beneath the breaſts, theſe bodies divided again, and become diſtinct and ſeparated, as below; when laid ſupine, they ſeemed to have but one body where joined, but when turned, there was a deep furrow between both, with each a diſtinct back-bone; each had nipples in their proper place reſpecting the ſeveral bodies, but one of each was ſeen before, the other behind with reſpect to the whole; they did not wake and ſleep together, they ſucked, cried and exonerated a-part; they were chriſtened *Aquila* and *Priſcilla*, tho' both females.

There was ſuch another birth in *Wales*, and the children lived ſo long till they could talk to each other, which they did in tears, when they thought that the one muſt ſurvive the other; but both happened to die together.

A new

A new Luni-ſolar Year, *and a perpetual* Almanac; *by Dr.* R. Wood. Phil. Collect. N° 2. p. 26.

THE garter Fig. 2 and 3. Plate V. ſhews the number of days, 30, 29, 30, 29; *&c.* which each of theſe twelve months of the year is to have; and in the buckle is diſcovered thro' a hole, the days of a thirteenth month, 31, 30; 31, 30, *&c.* to be added to the years, 2, 5, 7, 10, 13, 15, 18, 21, 24, 26, 29, 32, 34, 37; in all to 14 of 38, as in a cycle behind, which being ſuppoſed a moveable one 38th part every year backwards, or contrary to the months in the garter, its revolution is compleated in 38 years; and the 38th year current, or the year of the period or cycle is ſhewn thro' another hole; once every century, or to one year in 100, add one day, *viz.* to the firſt 50th year, or middle of the century, or rather to the firſt 70th year, (becauſe the firſt new moon, *March* 10th, 1680, happens a little after midnight, and after the vernal equinox) and then to every enſuing 100th year; which additional day being omitted every 230th or 240th century will balance the account for ever.

The new year and reckoning may beſt begin with the vernal equinox, or rather with the day of the new-moon happening near midnight about that time, as *March* 10th, 1680.

The *Egyptian* hieroglyphic of the year was a ſerpent carved into a circle or ring, with the tail in its mouth; but the emblematical garter will be much more proper for *England*, and is ſo exactly fitted to the moon's motion that one day will not be loſt or got in millions of years.

This almanac meaſures time principally by the moon, and hath a great and near relation to the annual motion of the ſun or earth; the unit or leaſt meaſure is a day, and the garter or luni-ſolar year will be at a medium within about a week, or a 50th part of the true ſolar year; that is, ſo near, that the difference will not be diſcerned by popular obſervation, and therefore it muſt needs anſwer the ends of husbandry and other civil affairs tolerably well, and come often near, and be ſometimes pretty exact; and at certain periods they balance each other, and have a kind of coincidence or agreement, much better than the ſun's courſe has with the *Julian* account.

The ancients generally computed their time by the moon, or by the lunar, or luni-ſolar year, as moſt of the eaſtern countries, if not the major part of mankind, do ſtill; which year conſiſted of real months to the number of 12 for the moſt part, and ſome years 13: It is plain from 1. Sam. c. 20. v. 5, 18, 24 compared with v. 27, 34 that the days of the *Jewiſh* month were the ſame with thoſe of the moon; and the *Greeks*, particularly the *Athenians*, according to the inſtitution of their wiſe legiſlator *Solon*, did thus reckon their time; as the *Romans* alſo did, till *Julius Cæſar* altered rather than mended the year.

Among the *Greeks*, *Meton*, *Calippus* and *Hipparchus* improved aſtronomy and rectified the accounts of time; *Hipparchus* the laſt of them flouriſhed about 90 or 100 years before *Julius Cæſar* altered the year; yet *Cæſar*, or his aſtronomer *Soſigenes* followed *Calippus* in framing the *Julian* year; for *Calippus*'s period of 76 years conſiſted of 27759 days as the ſame number of *Julian* years do; about three centuries and a half after *Cæſar*, the council of *Nice*, and about two centuries after that, *Dionyſius Exiguus* introduced the *Decennoval* cycle, called the golden number, for the celebration of *Eaſter*, following *Meton*, the firſt and leaſt exact of the three, or rather both *Meton* and *Cæſar*; two maſters, who were neither of them the beſt, and who would after ſome time diſagree, and remove to a greater diſtance from each other; tho' both *Cæſar* and the church might have had a much better patern in *Hipparchus*; and theſe their miſtakes have occaſioned thoſe anticipations and differences that have embarraſſed the accounts of time; and tho' many have propoſed laudable methods of rectifying theſe accounts, yet they ſtill built on the old foundations which were infirm; *Pope Gregory* XIII. in his reformation of the calendar, about 100 years ago, was obliged to wave the golden number, and yet he has only palliated the diſeaſe; ſo hard it is to cure an error in the firſt concoction.

The council of *Nice* appointed *Eaſter* to be kept the firſt *Sunday* after the firſt full-moon after the 21ſt of *March*; becauſe the vernal equinox, which was on the 25th in our Saviour's days, did then happen on the 21ſt; and therefore the *Gregorian* reformation has brought back the vernal equinox to that day; but in this garter-year, *Eaſter* will always be the firſt *Sunday* after the firſt full-moon of the new year; that is, after the vernal equinox, according to the true intent and meaning of the *Nicene* council, or as it was in the primitive times; and be but a week moveable, or a month leſs moveable than now, either according to the old or new ſtile; which might perhaps have prevented the difference, or ſerved as an expedient for reconciling the weſtern and eaſtern churches.

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The three cycles of *Meton*, *Calippus* and *Hipparchus* were all of them too large for the ſun, and primarily intended for the moon, or for a luni-ſolar year; however, that of *Hipparchus* came neareſt to both, and very near the moon's period.

Perhaps at firſt view Dr. *Wood*'s period of 38 years may be looked upon but as a double *Metonic*, or *Semi-callippic* one, &c. but upon farther conſideration, it will be found otherwiſe; for the periods of *Meton* and *Calippus*, as alſo that of *Hipparchus* were all of them too big, not only for the ſun's period, but alſo for that of the moon; whereas Dr. *Wood*'s, on the other hand, is too little for either, and requires one additional day almoſt every 100th year.

Meton's 19 years cycle, or *Enneadecaeteris* had 6940 days, whoſe double is 13880: *Calippus*'s period of 76 years had 27759 days, whoſe half is 13879 $\frac{1}{2}$: *Hipparchus*'s period of 304 years had 111035 days, whoſe eighth part is 13879 $\frac{3}{8}$: Whereas Dr. *Wood*'s period of 38 years hath but juſt 13879 days; and he choſe rather to take the revolution of the moon than that of the ſun, for his chief and primary meaſure of time; becauſe, firſt, the lunar phaſes and conſequently months, are more eaſily diſcerned than the ſun's annual period even by the meaneſt capacity; in the next place the obſervations on the moon have been more numerous, more exact, and of far greater antiquity; aſtronomers having had the help of eclipſes of very diſtant ages for their guide, in finding out very nearly the true meaſure of the moon's mean motion; laſtly, if we reckon by the moon, we may alſo do the like by the ſun; that is, by months and years too; whereas on the contrary, reckoning by a ſolar year, months are only empty names, and in meaſuring of times and ſeaſons, the moon is rendred of no uſe.

A new Lamp; *by Mr.* Boyle. Phil. Collect. N° 2. p. 33.

ABCD Fig. 4. Plate V. is a veſſel of latten well ſoldered; BC, EF are two bottoms ſoldered to that veſſel; FG is a pipe ſoldered to the above bottoms, whoſe aperture is in the great cavity FA; H is a hole in the pipe FG opening between the two bottoms BC, EF; I is another hole, to which is ſoldered a pipe IG bent upwards at G; PP is a ſmall veſſel fit to receive the wick of the lamp; LM is a ſlender pipe open at both ends, and ſoldered to the cover AD in L, and to the bottom EF in M; ſo that by that pipe the external air may communicate with the two bottoms, without penetrating into the cavity A F; N is a ſhort pipe ſoldered to a hole in the cover A D, ſo that thereby oil may be poured into the cavity A F, and it may be afterwards ſtopped cloſe with a cork: For the filling up this machine, you muſt ſtop the aperture G of the pipe I G with a long tube fitted for that purpoſe, as alſo the upper end of the pipe L M muſt be cloſe ſtopped, then let the oil be poured in by the aperture N; after which N is to be ſhut up exactly, and both the others, *viz.* G and L to be opened; then the oil will run thro' the pipe I G and fill the veſſel P, till its ſurface be in the ſame level with the hole H: Now it is eaſy to ſee that this lamp is free from all the inconveniences *Cardan*'s lamp is ſubject to; for, firſt, the air does not get into it by ſtarts, as it does in *Cardan*'s lamp; but when the oil in P P is waſted and comes to have its ſurface lower than the hole H, the oil from the cavity A F runs gently into P P, becauſe its place in the cavity A F is eaſily ſupplied by the external air, which gets up into the ſaid cavity A F thro' the pipe L M and the hole H: Secondly, when the air contained in the cavity A F comes to be rarified by heat, it drives out much oil, and ſo may choak up *Cardan*'s lamp; but in this the oil being ſo driven out gets into the ſpace between the two bottoms, as well as into the veſſel P P; now the ſaid ſpace, on account of its largeneſs, receiving twenty or thirty times more oil than the veſſel P P, it follows that the ſurface of the oil therein riſes twenty or thirty times leſs than if all the oil had been driven into the ſaid veſſel; therefore when we fill the lamp, we muſt take care that the pipe L be well cloſed, ſo that the air between the two bottoms, finding no paſſage may keep the oil from filling that ſpace, which by that means, when the hole L is open, will be fit to receive the oil driven by the rarefaction of the air into the cavity A F: Thirdly, the oil being always kept almoſt at the ſame diſtance from the flame, the wick will not be quickly conſumed: Fourthly, you have the conveniency of putting new oil into the lamp without moving or extinguiſhing it, only cloſing up G and L, and pouring the oil thro' N, as was ſaid above.

Infinitely infinite Fractions; *by Dr.* Rob. Wood. Phil. Collect. N° 3. p. 45.

INfinitely infinite fractions, or all the powers of the fractions, whoſe numerator is 1, are all of them together equal to 1.

$$\begin{array}{rcccccc}
 & & & & \multicolumn{3}{c}{\overbrace{\hspace{10em}}^{\text{P.}}}\\
\text{A.} & & \text{R.} & & \text{q.} & \text{c.} & \text{qq.}\\
1=\frac{1}{1} & = & \frac{1}{2} & :+ & \frac{1}{4}+ & \frac{1}{8}+ & \frac{1}{16},\ \text{\&c.}\\
\frac{1}{2} & = & \frac{1}{3} & :+ & \frac{1}{9}+ & \frac{1}{27}+ & \frac{1}{81},\ \text{\&c.}\\
\frac{1}{3} & = & \frac{1}{4} & :+ & \frac{1}{16}+ & \frac{1}{64}+ & \frac{1}{256},\ \text{\&c.}\\
\frac{1}{4} & = & \frac{1}{5} & :+ & \frac{1}{25}+ & \frac{1}{125}+ & \frac{1}{625},\ \text{\&c.}\\
\frac{1}{5} & = & \frac{1}{6} & :+ & \frac{1}{36}+ & \frac{1}{216}+ & \frac{1}{1296},\ \text{\&c.}\\
\text{\&c.} & & \text{\&c.} & & & &
\end{array}$$

A is a ſeries or rank of abſolute numbers, or rather of all the fractions, whoſe numerator is 1, which is ſuppoſed to be continued downwards *in infinitum:* R is another ſeries of all the roots, whoſe numerator is 1, of all the powers of ſuch fractions, ſuppoſed likewiſe to be continued downwards *in infinitum:* P are all the reſpective powers of ſuch fractions, *viz.* ſquares, cubes, &c. or ſo many ranks of geometrical proportionals, ſuppoſed to be continued *in infinitum*, both to the right hand, and alſo downwards.

Lemma, Each of the ſaid ranks of powers, together with their reſpective roots, is equal to each of the ſeveral numbers under A reſpectively.

Demonſtration, If from the line ab, Fig. 5. Plate V. you take for inſtance $\frac{1}{4}$ part towards a, ſuppoſe ac, and alſo from the other end of the ſame line ab, you take two ſuch parts, or $\frac{2}{4}$ parts towards b, ſuppoſe bd, *viz.* a number of parts leſs by two than the whole line ab was firſt ſuppoſed to be divided into, there will remain the line $cd = ac = \frac{1}{4}$ of ab; then again, if from cd you take $\frac{1}{4}$ thereof towards a, ſuppoſe ce, and from the other end $\frac{2}{4}$ parts of the ſame cd, ſuppoſe df, there will remain only $ef = ce = \frac{1}{4}$ of cd; and if you ſtill go on to take on the ſide towards a $\frac{1}{4}$ part of what was taken laſt, and twice as much on the other ſide towards b, there will be found between the two lines laſt taken always $\frac{1}{4}$ remaining of the line from which they were taken; from which $\frac{1}{4}$ part there may ſtill after the ſame manner be ſuppoſed to be taken two other ſuch lines; but if this be ſuppoſed to be actually done an infinite number of times, then there will nothing more remain, and ſo the continued diviſion on either ſide will come exactly to the point g, ſuppoſing ag to be $\frac{1}{3}$ of ab, and $bg = 2ag$; for, becauſe that which was taken away towards b was always twice as much as that taken away towards a, the total ſum of all the lines taken away towards b, which all together make up the line bg, muſt be twice as much as the line ag, which is the total ſum of all the lines taken away towards a, *viz.* $bg = 2ag$, and conſequently $bg + ag$, or the whole line ab, is equal to $3ag$, and conſequently $ag = \frac{1}{3}$ of ab. Q. E. D.

The like conſtruction and demonſtration may be made uſe of in taking away any other part of any quantity, and the like part again of the firſt, and ſo *in infinitum*; the total ſum of all the parts ſo taken, or ſuppoſed to be taken, ſhall be equal to any certain quantity, or part or fraction, whoſe denominator ſhall be leſs by an unit than the denominator of the firſt mentioned part; $\frac{1}{6}=\frac{1}{7}+\frac{1}{49}+\frac{1}{343}$, &c. $\frac{1}{9}=\frac{1}{10}+\frac{1}{100}+\frac{1}{1000}$, &c. And ſo, that which the incomparable *Archimedes*, in ſquaring the parabola, has only demonſtrated in one particular caſe, *viz.* $\frac{1}{3}=\frac{1}{4}+\frac{1}{16}+\frac{1}{64}+\frac{1}{254}$, &c. and that with a huge apparatus of preliminary propoſitions, amounting to a whole book, is here univerſally demonſtrated in all caſes, which are infinite, and by a very ſimple and eaſy method, in *Des Cartes*'s way.

Now if each of the ſaid ranks of powers, together with their reſpective roots, be equal to the ſeveral numbers of fractions under A, as is demonſtrated by the lemma; then is A the ſum of them all, or equal to them all; that is, $R + P = A = R + 1$; for R is the ſame with $A - \frac{1}{1}$ or 1, or but $\frac{1}{\infty}$ one infinite part bigger; wherefore $P = 1$, Q. E. D. *viz.* infinitely infinite fractions are equal to an unit, *viz.* to the leaſt integer root.

Hence it appears; 1. That there is a progreſſion *in infinitum.* 2. That there is a progreſſion not only to one infinite, but to ſeveral infinites, or rather to infinite infinites. 3. That this may be effected, that is, that this calculation may be made by a very finite and ſlender capacity. 4. That this whole progreſſion, or theſe infinite progreſſions may be numbred or ſummed up. 5. And that into a ſum not only not infinite, but ſo very ſmall as to be leſs than any number: It appears further, that ſome infinites are equal, others inequal, and that one infinite is equal to two, three, or more, either finites or infinites.

Experiments made with the liquid and ſolid Phoſphorus; *by Dr.* Fred. Slare. Phil. Collect. N° 3. p. 48.

THE liquid and ſolid phoſphorus do not materially differ, being both made of ſubſtances taken from a human body; the liquid is a ſubſtance mixed with a liquor, that, tho' it burns when in a ſolid maſs, will not offend the moſt tender hand; this phoſphorus retains not very long its light, if cloſe ſtopped up; yet in one ſort Dr. *Slare* obſerved a kind of flaſhing ſix or ſeven times ſucceſſively, tho' the glaſs were cloſely ſtopped: The other phoſphorus which is ſolid, differs not, as was ſaid, materially from the fluid, being made for the moſt part from urine; and the doctor was perſwaded it might as well be made of blood, if it could as eaſily be had in great quantities as urine, ſince the latter is the *Serum* of blood ſtrained thro' the kidneys: In this preparation, we have not only the common analyſis into phlegm, ſpirits, volatile ſalts, ſulphurs, or oils, but divers other extraordinary appearances before this grand product: The ſubſtance of this phoſphorus may be made as tranſparent as any reſinous body, and will melt like wax in warm water; and when cold, is exceeding tough, and cuts like *Luna Cornea*, or rather ſomewhat harder; when it is all under water, it ceaſes to ſhine, but whenever any part of it chances to emerge or get into the air, tho' the glaſs be hermetically ſealed, or perfectly ſhut, yet it will ſhine: Dr. *Slare* kept it in a large glaſs without water for ſeveral days, and yet it continually ſhone with little or no diminution either of its light or weight: Having written with the pointed end of a leſs vigorous phoſphorus ſome words, and removing them into the dark, the characters appeared very radiant and legible, like words written with a beam of light; and if theſe letters be carried to the fire, and ſuffered to grow warm, they will preſently turn into dark lines, and remain as long as good ink may be thought to do: This light is very diffuſive, for having weighed one grain, and counterpoiſed it in good ſcales, it continued to flame in the open air for ſeven or eight days, and looking cloſe upon it, it emitted a white flame into the ambient air, which a large piece does very remarkably: After all had been burnt out, there remained no aſhes or recrements, ſave only a little moiſture of a ſomewhat acid taſte; a larger piece, being ſuffered to burn out, yielded more moiſture, which taſted like a weaker *Oleum Sulphuris per Campanam*; its fume ſeems ſulphureous, both on account of its inflammability, as that it never loſes nor is diſſolved in water.

A Way to help Shortſightedneſs; *by Dr.* Hook. Phil. Collect. N° 3. p. 59.

DR. *Hook*, having found by many trials, that ſome ſhort-ſighted perſons could find little or no relief by the uſe of concave glaſſes, for ſeeing objects diſtinct at any diſtance, conſidered whether convex glaſſes might not be made uſeful for that purpoſe, and perceiving that any one may be made ſhort-ſighted, by looking thro' a deep pair of ſpectacles, ſuch as old men uſe; he concluded, that what glaſſes ſhould make this man, whilſt looking thro' theſe ſpectacles, to ſee things at a greater diſtance, would alſo aſſiſt any other naturally ſhort-ſighted; he then conſidered, that by the help of a convex-glaſs placed between the object and the eye, the image of the object may be made to appear at any diſtance from the eye; and conſequently all objects may thereby be made to appear at any convenient diſtance from the eye; ſo that the ſhort-ſighted eye will view the picture of the object, in the ſame manner as if the object itſelf were in that place; but then, becauſe the pictures are inverted, it will ſeem uncouth to one not uſed to ſee them in that poſture, he therefore bethought himſelf of the following expedients: 1. If it be only to read what is printed or written, there is nothing more required than the inverſion of it, and then to hold the convex at a due diſtance; for the picture of the letters will appear erect in the due place, for the eye to ſee and diſtinguiſh them very plainly. 2. For ſeeing to write, this is the beſt expedient, *viz.* that the ſhort-ſighted perſon ſhould firſt learn to read with his naked eye upſide down. 3. For diſtinguiſhing objects at a diſtance, he aſſerts from his own experience, that with a little practice of viewing objects inverted, one ſhall attain to as good an idea, and as true a knowledge of all manner of objects, as if ſeen erect in their natural poſture.

The beſt Form of Horizontal Sails *for a Mill*; *by Dr.* Hook. Phil. Collect. N° 3. p. 61.

THE invention is founded on the ſame principle with that of the ſailing of ſhips, and other veſſels upon the ſea; *viz.* upon diſpoſing and ordering of the vane or ſail in ſuch a man-a manner as to ſtand in the beſt poſture it is poſſible to move the arms of the mill, or the body of the ſhip: The firſt principle then, which is common to both, is that the vane or ſail be as near as poſſible, a perfect plane and ſmooth ſurface, without any bellying or curvity: Secondly, that the air may have as many paſſages between the parts of the vane or ſail as poſſible; that the moved air may come to it as freely as may be, without being intercepted by a ſtagnant air before it, to impede or divert its force: Thirdly, that the plane of the vane or ſail be put in the middle inclination between the way of the wind and that of the arm, or that of the body of the ſhip: Let A B, Fig. 6. Plate V. repreſent the ſtream or current of air or wind, moving from A to B, and let C repreſent the centre of the axis or ſpindle, ſtanding perpendicular to the horizon, upon which, at the top, is fixed at right angles the piece D H, making the two arms C D, and C H, upon the ends of which the vanes M N are moved on ſpindles, ſo as that the plane of the vane do always paſs thro' the point D; I ſay, theſe vanes ſo ordered will be always placed in the moſt advantageous poſition for moving the arms round upon the ſaid ſpindle, whoſe centre is C, in the order of D E F G H I K L D.

1. The vanes at D and H are placed in the moſt advantageous ſituation poſſible in thoſe two points; for, firſt, the vane M N at D being to move directly againſt the wind, the moſt advantageous direction is to turn its edge directly againſt it, thereby to give the leaſt reſiſtance poſſible, that being the only point, in which the vanes, ſuppoſed only a ſurface, draws not; and ſecondly, the vane M N placed at H ſtands the moſt advantageouſly, becauſe its motion being directly from or before the wind, it ſtands full croſs or oppoſite to its motion.

2. The vanes at E, F, G, and I, K, L ſtand the moſt advantageouſly, becauſe they divide the angle between the way of the wind, and that of the arms in thoſe points into two equal parts, and conſequently the wind impreſſes the greateſt force in the moſt direct way; for it is eaſy to be demonſtrated, that the force, impreſſed on the vane by the wind, is perpendicular to the ſurface, and conſequently that the obliquity of the force to the way of the arms, increaſed by the vanes ſtanding more full againſt the wind, will have a leſs proportion of power to promote its motion, than in the poſture here ſet; and ſuppoſing the vanes ſet ſharper to the wind, the diminution of the force impreſſed by the wind on its ſurface, will be greater than the augmentation of its power, by being moved more directly to

the way of the arms: The vane may be ſo ordered, as always to ſtand in this poſition; for let the vane be equally expanded on each ſide of its axis, by which the preſſure on its extremities are always counterpoiſed; then faſten on the lower end thereof a wheel, in diameter about ½ of the length of the arms from hole to hole; then fix a wheel upon the frame, in which the ſpindle of the arms do move, of half the diameter of the former, and containing half the number of teeth; then by a third ſmall wheel fixed under the arms, of a convenient bigneſs, communicate the motion of the one to the other; for by this means, each vane being ſo provided, they will, when once ſet right, always continue to be moved and diſpoſed in the true poſition deſired. See fig. 7.

This contrivance will not only be uſeful for all manner of common windmills, but alſo for water-mills on rivers, where no dam can be made, as may alſo the perpendicular vanes of other mills.

Yet whatever men may imagine concerning horizontal vanes, Dr. *Hook* doubts there never will be found a better and more advantageous way for receiving the ſtrength of the wind, or motion of the air, than perpendicular vanes made of a true form, ſo as that every part may draw alike.

Experiments with the Phoſphorus; *by Dr.* Fred. Slare. Phil. Collect. N° 4. p. 84.

IN order to try the elaſticity of this ſhining ſubſtance, when brought to a flame, Dr. *Slare* made the following experiment; he conveyed a quantity of it into a ſmall bubble of glaſs, as big as a nutmeg, but blown very thin in the flame of a lamp, that ſo it might be more affected by the elaſticity of the ſubſtance expanding itſelf into flame; then he hermetically ſealed up the end of the ſtem of this glaſs bubble, ſo that no air, nor any other thing could eſcape without breaking it; after which he approached the ſealed glaſs to the warmth of the fire, and, as he expected, ſoon found it kindle into a kind of flame, and continue to do ſo by emitting flames, and as it were filling up the whole capacity of the glaſs for ſome little time; after which it ſeemed to be extinguiſhed, without breaking the glaſs, or ſo much as cracking it: That he might ſatisfy himſelf what this flaming matter did reſolve into, he made another ſmall bubble with a pretty large tube for the neck, and left it open a-top, to be as a chimney to the fire below in the ball; then he made the matter to flame as before, by bringing it to the fire, and he found both the neck and upper part of the bubble lined with a yellowiſh ſulphur, which, tho' thus ſublimed, was not yet wholly diveſted of its ſhining property; but when a little warmed, the whole bubble would ſhine: In order to try at what rate it would burn in the open air, he made a piece of it flame merely by bringing it to the warmth of the fire, and he found it burn like a piece of nitre, but without any exploſion, for it only flamed away pretty briſk: He further obſerved, that it leaves a red tenacious matter upon its going out, not unlike to red wax, and ſo bitter as to ſet the teeth on edge, and diſſolve iron: Upon expoſing a large piece of it, that was carefully weighed, it continued a great while ſhining before the light was quite extinguiſhed; and examining the quantity of the liquor that it reſolved into, it was not a little ſurprizing to find it thrice at leaſt its firſt weight; ſome that taſted of it, called it ſpirit of ſulphur; others, ſpirit of ſalt: Upon putting a conſiderable piece under a glaſs, and upon the third and fourth exhauſtion, by which the glaſs was very well emptied, its light was much increaſed, and upon re-admitting the air, it returned to its former dullneſs: Endeavouring to blow it up into a flame with a pair of bellows, it ſeemed to be quite extinguiſhed, for it was a good while before any light appeared: All liquors are apt to extinguiſh this light, when the matter is plunged into them; neither will it ſhine or burn, tho' you boil it in the moſt inflammable liquors, even oil of olives, ſpirit of turpentine, or ſpirit of wine.

Roman Urns, *and other Antiquities near* York; *by Dr.* Liſter.
Phil. Collect. N° 4. p. 87.

ROMAN urns are found in ſeveral places throughout the whole kingdom; but the different workmanſhip of theſe veſſels, their compoſition, and the places where they were made, have been little obſerved: At *York* there were found, in the road or *Roman*-ſtreet without *Midſelgate*, and likewiſe by the river ſide, urns of three different tempers, *viz.* 1. Of a blueiſh grey colour, with a great deal of coarſe ſand wrought in with the clay. 2. Others of the ſame colour, having either a very fine ſand mixt with it full of *Mica*, or cat-ſilver, or made of clay naturally ſandy. 3. Red urns of fine clay, with little or no ſand; theſe pots throughout are quite of a red colour like fine bole; alſo many of theſe red pots are elegantly adorned with figures in *baſſo relievo*, and uſually the workman's

name,

name, which others have miſtaken for that of the perſon buried there, as *Januarius*, and ſuch like is found upon the bottom or cover; and that very name Dr. *Liſter* had ſeen upon ſeveral red pots, both at *York* and at *Aldborough*; theſe are varniſhed both inſide and out, of a bright coral colour: The compoſition of the firſt ſort of pots afforded the firſt hint of diſcovering the places, where they were made; the one about *Midway* between *Wilberfoſſe* and *Barnby* on the *Moor*, ſix miles from *York*, in the ſand hills, or riſing ground, where now the warren is: The other *Roman* pottery on the ſand hills at *Santon*, not far off *Bregg* in *Lincolnſhire*: In the firſt place, Dr. *Liſter* found broken pieces of urns, ſlag, and cinders; at the latter place there are ſtill remaining ſome of the very furnaces, whoſe ruins he takes to be thoſe *Metæ* or ſandy hillocks; it is remarkable that both the above-mentioned potteries are within leſs than a mile of the *Roman* road, or military high-way: The *Roman* urns above deſcribed, differ in theſe particulars from what pots are now uſually made amongſt us; 1. That they are without all manner of glazing with lead, which perhaps is a modern invention. 2. That a far greater quantity of ſand than clay is uſed, which alone made it worth their while to bring their clay to the ſand hills. 3. That they were baked either more gently, after long and thorough drying, or incloſed within certain coffins, to defend them from the immoderate contact of the flames, and that the rather, as there ſeem to be fragments of ſuch things to be found; it is certain the natural colour of the clay is not altered by burning, ſo that both the degrees of heat and manner of burning might be different; and Dr. *Liſter* was told, that one of theſe potſherds baked over again in our ovens will become red again: As to the two laſt kinds of urns, it is likely the firſt of them, with their particles of *Mica* therein, were made of a ſandy blue clay, and which abounds in the weſtern mountains of *Yorkſhire*, and particularly at *Carleton*, not far from *Ickley*, a *Roman* ſtation: The red urns ſeem to have been their maſter-piece, wherein they ſhewed the greateſt art, and ſeemed to glory moſt, and to eternize their names upon them: Their manner of glazing is far more elegant and more durable than the modern way of leading, which is apt to crack both with moiſture and heat; and at the fire it is certainly unwholeſome, by reaſon of the fumes lead uſually emits, being a quick evaporable metal; this ancient glazing ſeems to have been done by the bruſh or dipping; for both inſide

ſide as well as outſide of the urn are glazed, and that before baking: And ſomething of the materials of it ſeems to be hinted at by *Pliny Hiſt. Nat. Lib.* 36. c. 19. *Fictilia ex bitumine inſcripta non delentur*, the painting of pots with bitumen is indelible; and again Lib. 35. c. 15. *Tingi ſolidas ex bitumine Statuas*, the bitumen ſinks into ſolid ſtatues, which is ſomething more than glazing: The great plenty of theſe urns found in many parts of *England* ſeems to argue them of the *Engliſh* manufacture, and poſſibly wrought at the *Bole-mines* in *Cleveland*, of which clay alone they ſeem to be made; for that the barren tract of land called *Black-moor* was well known to the *Romans*, the jet-rings taken up with theſe urns do ſufficiently ſhew: Now jet and bole are no where elſe to be found in *England* but in that tract, being foſſils peculiar to theſe mountains; of theſe jet-rings ſome are plain and others wrought, but all of them of an extraordinary bigneſs, being at leaſt three inches diameter, yet the inward bore is not above an inch and a half, which makes them too little for the wriſts of any man, as they are much too big for the fingers; ſo that probably they were never wore either as *Armillæ* or *Annuli*, bracelets or rings: And now that the Doctor is upon the ſubject of *Roman* clay-work, he takes notice of *Cambden*'s opinion, who would have the obeliſks at *Burrow-Briggs* to be artificial, when they are nothing leſs, being made of one of the moſt common ſorts of ſtone, *viz*, of a courſe rag, or mill-ſtone grit; doubtleſs the bigneſs of the ſtone ſurpriſed him, either not thinking them portable, or perhaps not any *Engliſh* rock fit to yield natural ſtones of that magnitude; but they are certainly *Roman* monuments, becauſe pitched near *Iſurium*, a very noted and known *Roman* ſtation; beſides that theſe are trifles compared with the leaſt obeliſks at *Rome*: And as to the rocks whence they might be hewn, there are many of that ſtone near the river *Nid*, and upon the foreſt of *Knarsbourg*; and a little about *Ickley*, another *Roman* ſtation; within 16 miles of *Burrow-Briggs* there is one ſolid bed of this very ſtone, whoſe perpendicular depth alone will yield obeliſks at leaſt 30 foot long; and yet at *Rudſtone* near *Burlington* in the *Yorkſhire Woalds*, full 40 miles from theſe quarries, is an obeliſk of the very ſame ſtone, ſhape and magnitude of theſe abovementioned: And it muſt be obſerved that almoſt all the *Roman* monuments here in *England* were of this ſort of ſtone.

A ſtrange Appearance in the Air; *by Dr.* Andrew Spole. Phil. Collect. N° 5. p. 146. *Tranſlated from the* Latin.

IN *May* 1679 as Dr. *Spole* was travelling to *Upſal* ſomething extraordinary appeared to him upon a certain eminence near the city *Jonekoping*, under which at the diſtance of a quarter of a mile lies a lake of freſh water called the *Wetter*; for on the ſurface of this lake, which was then perfectly ſmooth, there being no breath of wind, the iſland *Wiſinsburg* was repreſented in ſo lively a manner as not to be exceeded by the moſt ſkilful painter; he could diſtinguiſh the windows of the houſes, and the men from the women, tho' the iſland itſelf was not then in view, becauſe of the interpoſing hills, and tho' it was at the diſtance at leaſt of 3 ¼ *Swediſh* miles, ten of which make nearly a degree; the ſun was then juſt riſen, and the Doctor's eye was between the place in the lake where the appearance was repreſented and the ſun; but when he quitted that place, the viſion diſappeared; and tho' he returned next day about the ſame time to the ſame ſtation, no ſuch thing was to be ſeen, nor was the lake ſo calm.

The Diſſection of an Oſtrich; *by Dr.* Edw. Brown. Phil. Collect. N° 5. p. 147.

THE oſtrich is eſteemed the largeſt and talleſt of winged or feathered fowl, being ſometimes eight foot high; the whole foot of this oſtrich was three quarters of a yard, and upon it he ſits when he reſts himſelf; but the foot properly ſo called, or longeſt claw, was only a quarter, the leſſer claw half a quarter and half a nail; the nail upon the longer claw was a nail long, or the ſixteenth part of a yard, above which ſtood 63 large ſcales one above the other, reaching up all along the forepart of the foot, or before thoſe bones which anſwer to the *Metatarſus*; the leſſer claw had no nail, and only eight or nine ſcales, one above the other, reaching no higher than the claw itſelf: The grain of the foot was like that of the ſkin of an elephant, but not ſo very hard, and it was yielding, and gave way upon preſſure like the foot of a camel, there being fat under it, and by this means it treads ſoft and without noiſe; but higher than the two claws, the ſkin looked ſcaly; every ſcale conſtituting an irregular quadrangle, pentagon, and ſometimes a hexagon: From the heel to the knee, or that part of the leg, which anſwers to the *tibia* in men, was ⅝ of a yard; the thigh was above a quarter, and very thick: Upon the breaſt there was a hard callous dark ſubſtance of an oval figure, a nail and a half in length, like that of a camel, upon which it reſts itſelf when it ſits, with its head upright; and in that poſture Dr. *Brown* thinks he ſleeps: His wing is too ſmall to cover his whole neck: There was alſo a callous part on the *Os pubis*, longer than the above-mentoined, but narrow; upon which, together with the callous part on the breaſt it reſts itſelf: The length of the body from the lower part of the neck to the extremity of the rump was one yard; the longeſt bone in the wing $\frac{3}{8}$ of a yard, and the neck a yard, excluding the head: The top of the head was flat, $\frac{1}{8}$ of a yard in length, meaſuring from behind the head to the end of the bill; it ſeemed to be hairy rather than covered with feathers; but there were beautiful white feathers on the neck, contrary to what ſome affirm; on the top of the head was a flat oval place, a nail in length, all callous, and without any hair or feathers, like the callous part of the breaſt, but not ſo thick, which might ſerve to defend the brain from the *Sereins*, a kind of dew, that falls in hot countries, and other injuries of the air: The gullet was very large, as well as long, but largeſt at the top near the head, where it was a nail and a half broad: The *Os hyoides* extended itſelf down on each ſide of the neck the length of half a quarter of a yard and half a nail: Beſides the many muſcles in the neck, for the motion of the *Vertebræ* and the head, there were two very elegant muſcles, which came from the inſide the *Thorax*, ariſing within the cheſt about the ſecond rib, and inſerting themſelves on each ſide of the wind-pipe, and they may be called *Directores Asperæ Arteriæ*: At the divarication or diviſion of the *Aſperia Arteria* on each ſide of the lungs, there was a ring bigger and ſtronger than any other ring of the wind-pipe: There were ſeveral glands in the neck near the gullet, of a pale colour like aſhes; but there were two very beautiful ones ſticking to the carotid arteries, as they come out of the breaſt, and theſe were blueiſh: The *Peritonæum* doubled and encompaſſed the ſtomach looſely; it had ſeven ribs, and the intercoſtal muſcles were broad, plain and beautiful; it had no prominent breaſt-bone, like other fowls, nor a narrow cheſt like many quadrupeds, but a broad breaſt, and a large firm *Sternum*, of the ſhape of a ſhield, and broader than that of a man; and indeed when it lowered its head, and bended its neck round to come in at a door, its breaſt was ſo broad, and its tread ſo different, that it is not at all like the entrance of a fowl, but in a ſurpriſing manner like that of a camel; but with this advantage, that the oſtrich ſupporting itſelf on two legs only, its entrance is more bold and graceful: The *Penis* was about an inch long, with a ſmall cartilaginous ſubſtance therein; the *Teſtes* lie very high near the kidneys and back-bone, were very ſmall and ſlender, and of a yellow colour: The ear was round and capable of receiving one's finger: The eye was large and blueiſh, almoſt as big as that of a man's: The natural colours of the feathers of this fowl were white, grey, and dun; the feathers of the inſide of the wings, breaſt, belly and neck were white, as alſo thoſe of the tail; but the reſt were greyiſh and of a dun colour: The *Rimula* of the *Larynx* was long, and the cartilages about it ſtrong, but without any *Epiglottis*, or any reſemblance to a human *Larynx*, tho' its voice he compared to the crying or ſhrieking of a hoarſe child, but more mournful and diſmal; the lungs were of a fine florid colour, but ſmall in proportion to the bulk of the *Aſpera Arteria*; they ſtuck cloſe to the back, and were perforated like thoſe of other birds; and upon blowing into the wind-pipe with a pair of bellows, they could not be made to riſe or fill; the heart had two ventricles, and about the bigneſs of a man's heart; but the right ventricle was much thinner, and the valves more fleſhy: It had two ſtomachs, *viz.* a crop and a gizzard, like granivorous fowls; but the crop, or firſt ſtomach differed much from that of other fowls, in that it was not placed without the breaſt as in them, but within the *Sternum*, as alſo that it was not round but long, like a bag, and of a vaſt bulk, lying lengthwiſe in the body; there were many glands found in the coats of this ſtomach, on its back part, reaching almoſt from one end to the other, to the number of a thouſand, about ten in breadth and a hundred in length; they lay between the coats of the ſtomach, and every particular gland diſcharged itſelf by a peculiar orifice, thro' the internal coat of the ſtomach into its cavity: Some of theſe glands were round and globular, ſome oval, ſome more flat, and of an irregular figure; ſuch as lay higheſt were roundeſt and thickeſt, and thoſe which lay more towards the bottom of the ſtomach or where it unites with the gizzard were broader and flatter; all theſe diſcharge a juice which promotes digeſtion: The gizzard was very large, the inner coat did not adhere ſo firmly as in other fowls, and was very thick and like flannel; the paſſage from the gizzard to the ſmall guts was very ſtreight: The guts were about 20 yards in length; the ſmaller guts beginning down from the ſtomach, were ten yards long, and the larger ones down from thence to the *Anus* were near as much: At the beginning of the great guts there were two *Inteſtina Cæca*, each of them a yard long, and they had a ſcrew or ſpiral valve within them, after the manner of the *Cæcum* of a rabbit; this ſcrew in both the inteſtines made about twenty turns; the extremity of the *Cæcum* was ſmall, not much differing from that of a man's: The excrement, which is diſcharged by the guts, is of two ſorts, a white, thin, glutinous excrement, which it mutes like a hawk; and after that, another ſort of excrement, reſembling very much that of ſheep, but bigger: The meſentery, tho' it held together ſuch a number of guts, is not thick, but a tranſparent membrane only; it is very large, and in ſome places above ⅛ of a yard deep or broad, meaſuring from the centre to the guts: The liver hath four lobes, and in colour is not much different from that of a man, but without any gall-bladder; there was a gland under the ſtomach, which might ſeem to be a ſpleen; but fowls and inſects are ſaid to have none: The pancreas was ſlender, and above a foot long: The kidneys were large, and of the length of a hand; as they lay both together, they were of the ſhape of a *Guitar*: The *Ureters* were firm, ſtrong, white and long; behind the kidneys lay two glands, ſomewhat oval, of about an inch and a half in length, and cloſe to the back-bone: The head reſembled that of a gooſe, and was ſmall in proportion to the whole body.

A new Theory *of* Viſion; *by Dr.* Briggs. Phil. Collect. N° 6. p. 167.

THE riſe of the optic nerves is very remarkable, for whereas other nerves ariſe in a flat manner from the baſis of the brain, theſe ariſe higher from two gibbous protuberances, called *Thalami nervorum opticorum*, as *llll*, Fig. 8. Plate V. ſo that the claſping of the ſeveral fibres upon them may very well reſemble the flexure of the ſtrings of a viol upon its bridge, which is likewiſe protuberant, or of a convex figure; now if we ſuppoſe two viols of equal bigneſs, and equally ſtrung, the uppermoſt ſtrings will have the greateſt degree of tenſion, and the others gradually leſs as they are removed from theſe; in the like manner Dr. *Briggs* ſuppoſes that the two uppermoſt fibres of the two *Thalami* have the greateſt tenſion, and the loweſt, the leaſt degree of tenſion, and the intermediate fibres, intermediate degrees; with this exception, that the internal lateral fibres are to be ſuppoſed to have leſs tenſion than the external lateral fibres; becauſe theſe laſt have the greater flexure, as appears from *dd* compared with *gg*: The ſuperior fibre therefore in one *Thalamus Opticus*, and its correſponding or ſuperior fibre in the other, which run in a like manner to the ſuperior part of each eye, he calls *Fibræ Concordes*, as *aa bb cc*, *&c.* and anſwer to uniſons in two viols or lutes, and therefore may be alſo called *Fibræ Homotonæ*; theſe ariſe ſeparately from the brain, nor was there any neceſſity of their union at their firſt origin, in order to their conſent, ſince they anſwer ſo exactly in their ſite and tenſion: In like manner, thoſe in the lowermoſt part of the *Thalami Optici* do correſpond, and run to the loweſt part of the eye, becauſe they have the leaſt flexure or tenſion; and therefore the intermediate fibres have conſequently a greater tenſion as they are nigher the top, or leſs as they are nigher the baſis, with this only difference, that the internal lateral fibres have leſs tenſion than the external: Hence it appears, that the fibres that are parallel, or in the ſame poſition are, as it were, ſymphonical, *viz.* the two ſuperior, two inferior, *&c.* in each *Thalamus Opticus* exactly anſwer each other in ſite and tenſion; ſo that when any impreſſion from an external object moves both fibres, it no more cauſes a double ſenſation than uniſons in two viols ſtruck together cauſe a double ſound: Now this paralleliſm of the fibres is much ſecured by the poſition of the fibres of the optic nerve, which keep their diſtinct order; for that the nerves decuſſate or croſs each other, or that they are blended together in ſuch a manner in their union, as to cauſe a confuſion in their fibres, is not to be imagined, but thoſe that are in the *Thalami Optici* on the right ſide run diſtinctly to the right eye, and thoſe on the left in the ſame manner: The caſe is plain in many fiſhes, where the two nerves are joined only by ſimple contact, and in the *Cameleon*, as is ſaid, not at all: Beſides this union of the nerves to keep up the ballance, is alſo much aſſiſted by the excellent contrivance of the muſcles; for it is very obſervable, that the *Obliquus inferior* ariſes from a peculiar foramen of the orbit, whereas all the reſt ariſe from its bottom at the exit of the optic nerve; ſo that both below by this muſcle, as above by the *Trochlearis*, a diſtortion of the eye is prevented; and as the two oblique muſcles are equally poiſed, ſo are the *Attolens* and *Deprimens*; for tho' the former be ſomewhat the larger muſcle, yet becauſe there is leſs force required to pull down than lift up the eye, their powers are equal; as for the lateral muſcles, they anſwer exactly both in ſite and bigneſs, and conſequently keep the balance, which is required to the conſent of the *Fibræ Concordes*: The inſertion of the fibres of the optic nerve into the bottom of the eye, and their keeping ſtill their diſtinct poſition, according as they riſe from the upper, lower, or lateral parts of the *Thalami Optici*, confirm what has been ſaid; for the optic nerve conſiſts of two coats, the exterior, produced from the *Dura Mater*, makes the *Sclerotica*, and the interior, ariſing from the *Pia Mater*, form the *Uvea*, and conſiſts of medullary fibres, which being in a diſtinct order expanded at their inſertion into the bottom of the eye form the *Tunica Retiformis*; this coat at firſt view, looks like a mucous ſubſtance, but if it be put into a cryſtal glaſs filled with clear water, and expoſed to the light or ſun, after the other coats are removed, this coat will become expanded, eſpecially if the water be a little warm, and will ſhew all the *Fibrillæ* very fairly and diſtinctly, like the fine threads of lawn; ſo that all theſe fibres keep their due poſition, and anſwer to diſtinct parts of objects, and obſerve that order and paralleliſm requiſite to diſtinct viſion.

From what has been ſaid ſeveral problems concerning viſion may be ſolved; as, 1. Why viſion is not double, ſince the organ is ſo? The anſwer is, that the *Fibræ Concordes* are like uniſons in a lute, and the rays ſtrike both at the ſame time: 2. Hence alſo it appears, why upon preſſing down one eye, an object appears double; *viz.* becauſe thereby its rays fall upon diſcordant fibres in the other eye not preſſed, ſo that there are two different ſenſations.

An explication of the figure, *a a*, *b b*, *c c*, *d d*, *&c.* are the *Fibræ Concordes* or concordant fibres of the optic nerves, as they ariſe alike from the *Thalami Optici llll*, which run alſo to like parts of the eye; where obſerve that *a a* are the two uppermoſt fibres, and are ſuppoſed to have the greateſt flexure; *b b*, *c c*, *d d*, the external lateral fibres; *e e*, *ff*, *g g*, the internal lateral fibres; *llll*, the two protuberances, called *Thalami Nervorum Opticorum*, from whence the optic nerves have their riſe; *h h h h h*, the parts of the brain that lie under them; *i i*, the optic nerves; +, the place of their union; *m m*, the eyes diveſted of the *Sclerotica* and *Uvea*; *n n*, the *Proceſſus Ciliares* lying juſt under the *Iris*; *o o*, the *Pupillæ* or ſights.

The Quadrature of the Circle; *by* M. Leibnitz. Phil. Collect. N° 7. p. 204.

ARchimedes, by inſcribing and circumſcribing polygons to a circle, ſhews a way of giving the limits within which the circle falls, or of giving approaches, by which the ratio of the circumference to the diameter is more than 3 to 1, or than 21 to 7, and leſs than 22 to 7; which method has been ſince proſecuted by others, as by *Ptolemy*, *Vieta*, *Metius*, and moſt of all by *Ludolphus Van Ceulen*, who has ſhewn the circumference to be to the diameter, as, 3. 141 5926535897, *&c.* to 1. 000000000000; but theſe ſort of approaches, tho' uſeful in practical geometry, give no ſatisfaction to the mind: Many have profeſſed to have found the true quadrature, as *Cardinal Cuſanus*, *Orontius Fineus*, *Joſeph Scaliger*, *Thomas Gepherander*, and *Thomas Hobbs*, but all of them falſely, being diſproved by the calculations of *Archimedes*, or by thoſe of *Van Ceulen*.

The quadrature of the circle, or the turning it into an equal ſquare, or any other right-lined figure, which depends upon the ratio of the circle to the ſquare of its diameter, or of the circumference to its diameter, may be underſtood to be fourfold, *viz.* either by calculation, or by linear conſtruction; and each of theſe again may be either perfectly exact, or elſe almoſt, or pretty near; the quadrature by accurate calculation, M. *Leibnitz* calls the analytical; that by accurate conſtruction, the geometrical; the quadrature by calculation pretty near, he calls the approach; and by conſtruction pretty near, the mechanical: The approaches have been furtheſt carried on by *Van Ceulen*; and ſeveral mechanical conſtructions have been given by *Vieta*, *Huygens* and others: The accurate geometrical conſtruction may be obtained, by which not only an entire circle may be meaſured, but alſo any ſection or arch thereof, and that by an exact and ordinate motion, but ſuch notwithſtanding as ſuits with tranſcendental curves, which are erroneouſly accounted mechanical; tho' in reality they are as geometrical as thoſe which are commonly ſo eſteemed; tho' they are not algebraical, nor can be reduced to equations algebraical, or of certain degrees, they having degrees proper to themſelves, which tho' not algebraical, are notwithſtanding analytical: The analytical quadrature, or that by accurate calculation, may be again ſubdivided into three kinds, *viz.* into the analytical tranſcendent, the algebraical, and the arithmetical; the analytical tranſcendent is to be obtained by equations of degrees indefinite, hitherto conſidered by none; as if $X^x + X$ be equal to 30, and X be ſought, it will be found to be 3, becauſe $3^3 + 3$ is equal to $27 + 3$, or 30: The algebraical is done by vulgar numbers, tho' irrationally vulgar, or by the roots of common equations, which for the general quadrature of the circle, or its ſectors, is indeed impoſſible: Now there remains the arithmetical quadrature, which is performed by certain ſeries's, exhibiting the quantity of the circle exact by a progreſſion of terms; firſt, rational, ſuch as is here propounded: M. *Leibnitz* therefore found, that if the ſquare of the diameter be put 1, the area of the circle will be $\frac{1}{1} - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9}$, &c. *viz.* the entire ſquare of the diameter being diminiſhed, that it may not be too big, by a third part; and again, becauſe hereby too much is taken away, being augmented by one fifth; and again, becauſe by this laſt too much is added, diminiſhed by one ſeventh, and ſo on continually: And the firſt quantity will be too great, *viz.* 1, but the error will be leſs than $\frac{1}{3}$; the next too little, *viz.* $1 - \frac{1}{3}$, but the error will be leſs than $\frac{1}{5}$; the third too much, *viz.* $1 - \frac{1}{3} + \frac{1}{5}$, but the error will be leſs than $\frac{1}{7}$, &c. The whole ſeries contains all the approaches together, or the values both greater than they ought to be, and leſs than they ought to be: So that by continuing the ſeries, the errors may be made leſs than the fraction given, and conſequently leſs than any aſſignable quantity; whence it follows, that the whole ſeries muſt give the true value; and tho' the ſum of the whole ſeries cannot be expreſſed by one number, and that the ſeries be infinitely continued, yet becauſe it conſiſts of one regular method of progreſſion, the whole may ſufficiently enough be conceived by the mind; and if *Van Ceulen* could have given a rule by which his numbers 314159, &c. could have been continued *in infinitum*, he would have given us the arithmetical quadrature exact in whole numbers, which is here done in fractions; the terms of which, *viz.* $\frac{1}{1}$, $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$, $\frac{1}{9}$, &c. are in continued harmonical progreſſion; and a ſeries made by ſkipping, as $\frac{1}{1}$, $\frac{1}{5}$, $\frac{1}{9}$, $\frac{1}{13}$, $\frac{1}{17}$, &c. is alſo an harmonical progreſſion; and $\frac{1}{3}$, $\frac{1}{7}$, $\frac{1}{11}$, $\frac{1}{15}$, $\frac{1}{19}$, &c. is alſo a ſeries of harmonical proportionals; wherefore, ſince the circle is $\frac{1}{1} + \frac{1}{5} + \frac{1}{9} + \frac{1}{13} + \frac{1}{17}$, &c. $- \frac{1}{3} - \frac{1}{7} - \frac{1}{11} - \frac{1}{15} - \frac{1}{19}$, &c. by ſubſtracting the latter partial ſeries from the former partial ſeries, the circle will be the difference of two ſeries in harmonical progreſſion; and becauſe the ſum of any number of terms in harmonical progreſſion, how many ſoever, may by ſome compendium be obtained; hence compendious approaches, if after *Van Ceulen* there be any need of them, may be deduced; if one would in this ſeries take out the terms affected with the ſign —, by adding the two next into one, $+\frac{1}{1}-\frac{1}{3}$, and $+\frac{1}{5}-\frac{1}{7}$, and $+\frac{1}{9}-\frac{1}{11}$ and $+\frac{1}{13}-\frac{1}{15}$, and $+\frac{1}{17}-\frac{1}{19}$ and ſo on, he will have a new ſeries for the magnitude of the circle, *viz.* $\frac{2}{3}$ (that is, $\frac{1}{1}-\frac{1}{3}$) $+\frac{2}{35}$ (that is, $\frac{1}{5}-\frac{1}{7}$) $+\frac{2}{99}$ (that is, $\frac{1}{9}-\frac{1}{11}$) &c. wherefore the ſquare inſcribed being $\frac{1}{4}$, the area of the circle will be $\frac{1}{3}+\frac{1}{35}+\frac{1}{99}+\frac{1}{195}+\frac{1}{323}$, &c. but the numbers, 3, 35, 99, 195, 323, &c. by ſkipping are taken out of the ſeries of ſquare numbers, 4, 9, 16, 25, &c. diminiſhed by an unite, and ſo make the ſeries, 3, 8, 15, 24, in which ſeries every fourth member after the firſt is a term of M. *Leibnitz* ſeries; but he found, which is worth obſerving, the ſum of this infinite ſeries, $\frac{1}{3}+\frac{1}{8}+\frac{1}{15}$ &c. to be $\frac{3}{4}$; nay, and by culling out by ſingle ſkipping, as $\frac{1}{3}+\frac{1}{15}+\frac{1}{35}$, &c. the ſum of this infinite ſeries to make $\frac{2}{4}$ or $\frac{1}{2}$; but if out of this again, another progreſſion be culled by ſingle ſkipping, as $\frac{1}{3}+\frac{1}{35}+\frac{1}{99}$, &c. the ſum of that infinite ſeries will be the ſemicircle, the ſquare of the diameter being 1: Now, becauſe by the ſame means the arithmetical quadrature of the hyperbola is obtained, the whole harmony is here repreſented at one view.

1 2 3 4 5 6 7 8 9 10 11 12 13, &c.
1 4 9 16 25 36 49 64 81 100 121 144 169, &c.
0 3 8 15 24 35 48 63 80 99 120 143 168, &c.

$$\frac{1}{3}\ \frac{1}{8}\ \frac{1}{15}\ \frac{1}{24}\ \frac{1}{35}\ \frac{1}{48}\ \frac{1}{63}\ \frac{1}{80}\ \frac{1}{99}\ \frac{1}{120}\ \frac{1}{143}\ \frac{1}{168}, \text{\&c.} = \frac{3}{4}$$

$$\frac{1}{3} - \frac{1}{15} - - \frac{1}{35} - - \frac{1}{63} - - \frac{1}{99} - - \frac{1}{143}, \text{\&c.} = \frac{2}{4}$$

$$\frac{1}{8} - - \frac{1}{24} - - \frac{1}{48} - - \frac{1}{80} - - \frac{1}{120} - - \frac{1}{168}, \text{\&c.} = \frac{1}{4}$$

$\frac{1}{3}$ - - - - $\frac{1}{35}$ - - - - - - $\frac{1}{99}$, &c. = to the circle ABCD, Fig. 9. Plate V. whoſe inſcribed ſquare is $\frac{1}{4}$.

$\frac{1}{8}$ - - - - - - $\frac{1}{48}$ - - - - - - $\frac{1}{120}$, &c. = to the hyperbola CBEHC, whoſe power ABCD is $\frac{1}{4}$.

To the aſſymptotes AF, AE, at right angles to each other, let there be deſcribed the curve line of an hyperbola GCH, whoſe vertex is C; and ABCD, the power or ſquare, to which every rectangle made of the ordinate as EH, and the intercepted part AE, is always equal; about this ſquare let a circle be drawn, and let the hyperbola be continued from C to H, ſo that AE be double to AB; then putting AE 1, AB will be $\frac{1}{2}$, and its ſquare ABCD will be $\frac{1}{4}$, and the circle, whoſe power ABCD is inſcribed, will be $\frac{1}{3} + \frac{1}{35} + \frac{1}{99}$, &c. but the portion of the hyperbola CBEHC, whoſe power inſcribed is the ſame ſquare $\frac{1}{4}$, which repreſents the logarithm of the ratio of AE to AB, or of 2 to 1, will be $\frac{1}{8} + \frac{1}{48} + \frac{1}{120}$, &c.

Pen-park-hole *in* Glouceſterſhire; *by Capt.* Sturmy, *and Capt.* Collins. Phil. Tranſ. N° 143. p. 2.

AFTER a perpendicular deſcent by ropes, which are fixed at the top of an old lead-ore pit, of almoſt four fathoms, and from thence a more oblique deſcent of three fathoms between two great rocks; Capt. *Sturmy* in *July* 1669, came to the mouth of this ſpacious place, from which he was let down by ropes 25 fathoms perpendicular into a very large place reſembling the form of a horſe-ſhoe; and at length he came to a river or great water, 20 fathoms broad, and eight fathoms deep; the miner who went down with him would perſuade him, that this river ebbed and flowed; but ſtaying there from three hours flood to two hours ebb, he found no alteration in it; beſides, its waters were freſh, ſweet and cool, and its ſurface, as it was then at eight fathom deep, lay lower than the bottom of any part of the *Severn* ſea, ſo that it could have no communication with it: Here are ſeveral ſtrange places, the flooring is a kind of white ſtone enamelled with lead ore, and the pendant rocks are glazed with ſalt-petre, which had diſtilled upon them from above, and which time had petrified.

Capt. *Collins* deſcending thither found the tunnel from the ſurface to the opening of the cavity below, 39 yards; then the hole ſpreading into an irregular oblong figure, its greateſt length was 75 yards and greateſt breadth 41; from the higheſt part of the roof to the water was 19 yards; the water was then, *viz. Sept.* 1682, in a pool; at the north end, which was the deepeſt part, it was 27 yards in length, 12 in breadth, and 5 ½ in depth; there appeared two rocks above the water all covered with mud, but the water itſelf was ſweet and good; there was a large circle of mud round the pool, and reaching far up towards the ſouth end; which ſhewed that the water at other times had been ſix yards higher than it was then: The tunnel or paſſage down was ſomewhat oblique, very rugged and rocky; in ſome places it was two yards wide, and in others 3 or 4; but there was nothing obſervable therein, ſave here and there ſome of that ſpar which uſually is found in mines of lead-ore: In the way 30 yards down, there runs in ſouthward a paſſage 29 yards in length, parallel to the ſurface above; it was two or three yards high, and commonly as broad, and equally rocky with the tunnel, with ſome appearances of ſpar, but nothing elſe obſervable in it except a few bats: The cavity below was in like manner rocky and very irregular; the candles and torches burned ſo clear as to diſcover its whole extent; nor was the air in the leaſt offenſive: The bottom of this hole, where the land-waters gather, is 59 yards from the ſurface of the earth; and by calculation the ſame bottom is twenty yards above the higheſt riſing of the *Severn*, and lies at about the diſtance of three miles from it into the land.

Expe-

Experiments *made for altering the Colour of the* Chyle *in the* Lacteals; *by Dr.* Liſter. Phil. Tranſ. N° 143. p. 6.

DR. *Liſter* cauſed a dog to be fed, and after four hours he opened the abdomen, and making a ſmall inciſion in the *Jejunum*, he injected an ounce or two of a clear tincture of indigo diſſolved in fair water and ſtrained; this done he ſtitched up all again, and the dog was turned upon his legs; in an hour and a quarter the ſtitches were cut up, and there was obſerved a copious diſtribution of chyle, and very turgid lacteals, but as white as ever; and tho' he carefully ſearched the guts, yet he did not perceive any where any of the injected liquor.

He gave another dog, which had been kept faſting 40 hours, a very little fleſh without water, about five hours before the injection of the tincture of indigo; which was done in the ſame manner as above; only it was this time well warmed, and about 12 ounces thrown up the *Duodenum*, and down the *Ileum*; here the guts were obſerved to be empty and not the leaſt appearance of any lacteals in the meſentery; after full three hours, the ſtitches were cut again, and upon carefully examining the meſentery, many lacteals were found of an azure colour; and cutting ſome of the biggeſt of them aſunder, there iſſued out a thick blueiſh chyle; whence it plainly appears that the lacteals receive their contents from the cavity of the inteſtines.

An Obſervation of the Beginning of the Lunar Eclipſe, *which happened* Aug. 19, 1681 *in the Morning, made in the Iſland of* Madagaſcar; *by Mr.* Tho. Heathcot; *and communicated by Dr.* Flamſtead. Phil. Tranſ. N° 143. p. 15.

MR. *Heathcot* was ſurgeon to a ſhip, which lay then at the bottom of a deep bay, on the weſtern ſhore of the iſland, and that part which the *Portugueſe* and our maps call *Terra del Gada*; he had a quadrant of two foot radius, and a teleſcope of nine foot, but no clock; to ſupply which defect, he made a pendulum of a ſtring and a bullet 39 inches long, that each ſingle vibration might anſwer a ſecond of time; as ſoon as he ſaw the true ſhadow enter on the moon's limb, he cauſed his friends, who aſſiſted him, to make the pendulum vibrate, and count its vibrations; and they had numbred 140, that is 2′ 20″, when he took the height of *Procyon* (then eaſt of the meridian) 25° 39′; the next day he obſerved the ſun's meridional height with the ſame quadrant, whence he found

the

the latitude of that place 19° 29′ ſouth; hence the time when he took the height of *Procyon* is found 4 h. 51′ in the morning, and ſubſtracting the 2′ 20″ paſſed ſince the obſerved beginning of the eclipſe, its

	h.	m.	ſ.
True beginning was at — — — — — —	4	48	40
Which at the obſervatory at *Greenwich* Dr. *Flamſtead* obſerved — — — — — —	1	50	40
Wherefore this part of *Madagaſcar* more eaſterly	2	58	00

Or, 44° 30′

The Diſſection of a Rattle-Snake; *by Dr.* Tyſon. Phil. Tranſ. N° 144. p. 25.

UPON the diſſection of a rattle-ſnake, Dr. *Tyſon* found both its external and internal parts ſo like, in almoſt all reſpects, to thoſe of a viper, that he does not ſcruple to place it in that claſs, and from the rattle, which ſufficiently diſtinguiſhes it from other ſerpents, to name it *Vipera Caudiſona.*

It was four foot five inches long; its greateſt compaſs, which was in the middle, was 6½ inches; that of the neck three inches; near the rattle two inches; the top of the head was flat as in the viper; and by the protuberance of the *Maxillæ* or jaws it ſomewhat reſembled the head of a bearded arrow; at the extremity of it were the noſtrils; between them and the eyes, but a little lower, were two other orifices, which he took for ears; but he afterwards found they only led into a bone that had a pretty large cavity, but no perforation; vipers have not theſe orifices in the head, and *Charas* ſaith, that they hear by the noſtrils, and that not only the olfactory but the auditory nerves run into them: The eye was round, and about a quarter of an inch in diameter; there was a large ſcale jutting over the eye, which ſeemed to ſerve it as an eye-lid; but he could not perceive it capable of cloſing, tho' inwardly it ſeemed to have a *Membrana Nictitans,* which removes any duſt that may adhere to the eye: The ſcales on the head were the ſmalleſt of any; thoſe on the back largeſt, and ſo proportionably larger on the biggeſt part of the body, and diminiſhing again to the joining of the rattle, all of them in figure ſomewhat reſembling parſnip-ſeeds; their colour was various; the ſcales on the head were like the feathers on the back of a green-finch, ſpeckled with ſmall black ſpots, four of which were large and very remarkable; thoſe on the back were a dark *feuille-morte* and ſpeckled, by this mixture of colours forming a curious chequer-work on the back; but as they drew nearer the tail, they became darker, and at laſt almoſt black; the ſcales on the back had an edged riſing in the middle, which was ſtill leſs protuberant nearer the ſides, where they were flat: The belly ſeemed flat, covered with long ſcales of a yellowiſh colour, and ſpeckled black; from the neck to the *Anus* were number'd 168; beyond the *Anus* were two half ſcales; from thence were 19 whole ſcales of a black lead-colour, with yellowiſh edges; and from thence again to the rattle ſix rows of ſmaller ſcales of the ſame colour; the ſcales of the belly were joined to each other by diſtinct muſcles; the lower tendon of each muſcle being inſerted into the upper edge of the following ſcale, and the other tendon of the ſame muſcle inſerted about the middle of the preceeding ſcale; theſe muſcles were more fleſhy towards the middle of the ſcale, and then the fibres run obliquely aſcending; to each ſcale a rib was appropriated, whoſe point did join with the extremity of it, which muſt conſiderably promote the uſe nature deſigned them for, *viz.* the ſtrengthening them to perform their reptile motions; for the ſcales are ſo many feet, which being free and open below, do thereby take hold of the ground, and ſo contract their body forwards, and then ſhoot it out again, and thus they perform their motions; hence it is that on the rocks they move quicker than on the earth or on plains, becauſe there they have the firmer footing; but in ſoft ground tho' their belly be flat, yet they can contract it to an ellipſis, or an acute angle, that ſo they may take the deeper hold, as is obſerved in a viper; this coat of armour, which is for their defence, is ſo curiouſly contrived, that tho' it cover the whole body, yet by its frequent jointings it admits of various motions.

Having placed this rattle-ſnake on its back, and opening it; the tendons of the abdominal muſcles were obſerved to form a *Linea Alba* in the middle of the ſcales of the belly; where likewiſe a large blood veſſel did run, riſing from the *Vena Cava*, towards the lower part of the liver: The windpipe, which is common to it with the viper-kind, as ſoon as it enters the breaſt preſently meeting with the lungs, conſiſts only of ſemi-annular cartilages, which being joined at both ends to the membrane of the lungs, is internally quite open, and immediately tranſmits the air to the veſicles of the lungs; for dividing the windpipe, it was perceived to be eaſily extended above 1 ½ inch wide; whereas before it meets with the lungs, the cartilages are annular; the *Trachæa* or wind-pipe was 20 inches long, terminating near the heart, and the beginning of the liver, and reaching to that part of the lungs, which formed the great bladder; the cartilages of the *Trachæa* near the beginning were $\frac{3}{8}$ of an inch, but towards the end $\frac{1}{2}$ of an inch, lying flattiſh from end to end; theſe cartilages were not ſo diſtinct as in other animals, but often running into each other: The lungs begin from the throat, and run down three foot in length; the upper part of them, which lay in the forepart of the body, for the length of a foot, and reached to the heart, conſiſted of ſmall veſicles or cells, like the lungs of a frog; but from the frequent branchings of the blood-veſſels there, they appeared of a florid red; this part is tapering in proportion to the body; the loweſt part of it near the heart, being moderately blown, was 5 $\frac{1}{2}$ inches in compaſs; a little lower, for the ſpace of four inches, the cells gradually diſappeared, ſo that they ſeemed at laſt to form only reticular compages of *Valvulæ Conniventes* on the inſide of the membrane of the lungs, and the greateſt compaſs here was about 6 $\frac{1}{2}$ inches; but from thence to the end of the lungs there was only a large bladder, without any cells, compoſed of a thin, but ſtrong tranſparent membrane, whoſe compaſs was, after blowing, 8 $\frac{1}{2}$ inches: The lungs of the *Salamandra Aquatica*, and of ſome other animals, are only two large bladders; thoſe of the frog, crocodile, *&c.* are two large lobes full of membranous veſicles or cells; but the rattle-ſnake, and all of that family, tho' they have but one lobe of lungs, yet therein they comprehend the two former ſorts; the fore-part being full of numerous veſicles, and the latter part an entire large bladder: In the land-tortoiſe there are two lobes, one on each ſide; but theſe are ſubdivided into ſeveral others, according to the partitions of the ribs, which are fixed to the ſhell, and they lie chiefly in the belly; that is, in the loweſt part of the body; but what is remarkable, is, that where the *Bronchiæ* firſt enter theſe ſubdiviſions, they are reticular, and then they form a large cavity; ſo that in theſe animals, where the *Niſus* of reſpiration is not ſo frequent, nature provides a ſufficient ſtore-houſe for the air in theſe large bladders, whence it is diſperſed according to the exigency of the animal oeconomy; for tortoiſes, vipers, rattle-ſnakes, frogs, toads, *&c.* which ſleep a great part of the year, as previouſly to this repoſe they take in their ſtore of food, ſo perhaps that of air too; for when thus ſtupidly a-ſleep, and ſometimes to all appearance dead, it may be queſtioned whether they have any motion of thoſe parts, which is requiſite in drawing in freſh air in inſpiration; thus alſo the *Salamandra Aquatica* has inſtead of lungs two large bladders, probably for this reaſon, that it might not be obliged ſo often to raiſe itſelf out of the water in drawing in freſh air, when the former is ſpent and decayed: In a viper, which remained alive ſome days, after the ſkin and moſt of the *Viſcera* were ſeparated, the lungs were not obſerved all that time to riſe and fall as in inſpiration and expiration, but appeared equally extended with air; only as ſoon as it died, it expired, and the lungs fell; but the ſtomach was empty, and was ſo for ſome conſiderable time; as was alſo that of the rattle-ſnake, which for four months at leaſt had eat nothing; ſo that, tho' they can live ſo long without food, yet nature is mighty provident in ſupplying them with air, by furniſhing them with ſuch large receptacles for it.

The *Oeſophagus*, or gullet, which ſerves only in moſt other animals for tranſmitting the food into the ſtomach, ſeems here to be intended by nature for ſomething more, and to be uſed upon occaſion for a ſtomach or ſtomachs; for upon blowing up this part, two large tumours were obſerved, nor was the true ſtomach capable of ſuch an extenſion; the whole length of the *Oeſophagus* was two foot three inches and a half; the length of the proper ſtomach was five inches, lying in a ſtreight line with the *Oeſophagus*, but thicker than it, with a remarkable coat over and above on the inſide, eaſily diſtinguiſhable by its colour, ſubſtance and folds, and jutting over the inſide of the gullet, and the ſame in all reſpects as in the viper; from the *Pylorus*, the *Ductus* was again ſtraitned for half an inch, and then it formed a large inteſtine, which afforded an agreeable ſight, on account of the weaved wrinkles of its internal coat; and this gut, after ſome ſmall windings, ended at laſt in the *Rectum*, whoſe capacity was much leſs than that of the former; there were obſerved in the ſtomach and gut a great number of *Lumbrici Teretes*, a diſeaſe that vipers likewiſe are ſubject to: Dr. *Tyſon* takes the ſwellings in the gullet to do the office of a crop in birds, and of the paunch in quadrupeds, as being convenient receptacles for the food the ſtomach cannot well receive at once, and that the more neceſſary as they feed but at one time of the year; And it is reported, that upon occaſions of danger they ſhelter their young in theſe receptacles.

The heart was placed near the bottom of the *Trachæa*, and on its right ſide; its length was an inch and a half; its figure rather flat than round; it was encompaſſed with a *Pericardium*, and the auricle was larger than the heart itſelf; and it had but one ventricle; the valves were ſmall and fleſhy; and the inſide of the ventricle was diſtinguiſhed by four or five croſs furrows.

A little below the heart lies the liver, which was about an inch wide in the largeſt place, and ſeemed divided on one ſide by the *Vena Cava* into two lobes of an unequal length; for the one on the left ſide was about ten inches, and the other on the right about a foot long; it was of a brown red colour, and its uſe, no doubt, was for ſeparating the gall, which was contained in a bladder ſituated at ſome diſtance below it; this gall-bladder was two inches long, the colour of the gall contained in it was graſs-green, which ouzing thro' its coats had deeply tinged all the adjacent parts; the *Ductus*, whereby it is conveyed from the liver, is obſcure, and hard to be found; but the *Ductus Cyſticus*, by which it diſcharges itſelf into the inteſtine, is manifeſt enough; it ariſes from the top of the bladder, and gently deſcending, paſſes thro' that part, which *Charas* takes for the *Pancreas*, but which the ancients called the ſpleen, and ſo enters the beginning of the larger inteſtine: The fat, which was very plentiful, is ſaid to be uſed by the phyſicians of *Mexico* with good ſucceſs in the *Sciatica*, in pains of the limbs, and for diſcuſſing preternatural tumours; the membrane to which it adhered was taken for the *Omentum*, and encompaſſed all the parts contained in this lower belly, and was joined to both ſides of the ribs; and ſo running to the *Rectum*, and forming a bag that enveloped the parts, it was free towards the belly.

The two kidneys, which lay to the back on each ſide of the ſpine, but not very firmly conjoined, were about ſeven inches long; the right was ſomewhat longer than the left, and each about half an inch broad; and tho' their ſubſtance ſeems one continued body, yet it is plainly diſtinguiſhable into ſeveral leſſer kidneys; for they ought to be reckoned as many, as there are diſtinct ſyſtems and orders of veſſels, which were placed at length, and not piled on each other; the ureters did run almoſt the length of the kidneys, being a common trunk, that received the leſſer branches, that went to each ſingle gland, and did terminate near each other in the *Cloaca*, making an eminence there; for rattle-ſnakes, like birds, have a *Cloaca*, which in the female viper, receives the orifices of the *Ureters*, and the two *Uteri*; near the verge of the *Cloaca* were obſerved two other orifices, which ſeemed to be covered by the folding of the ſkin, and they led into two bags, which Dr. *Tyſon* calls ſcent-bags; one of them was about an inch long, and as big as a gooſe-quill, but tapering towards the end, and from the colour of the liquor it contained, it appeared darkiſh; the other bag was ſomething leſs; the liquor they contained was a little thick, and of a ſtrong and very unpleaſant ſmell.

The teſticles were very diſproportionate in length, the right being two inches and a quarter long, the left one and a half, ſcarce ſo big in compaſs as a gooſe-quill; their colour was white, as is uſual; the *Vaſa Præparantia* had nothing uncommon; but the *Deferentia* were remarkable; for tho' they did run in a ſtreight line almoſt from the *Teſtes* to the *Penis*, and formed no large body; yet this *Ductus* was ſo often involved, that were it unravelled and extended its whole length, it would be twice as long: There were four *Penes*, two on each ſide, which lay ſheathed in the body; towards the root they were ſingle of each ſide, and thick ſet with prickles, whoſe points looked backwards; but from hence the *Penes* were divided, and formed two round bodies of the bigneſs of a ſmall gooſe-quill, about ¾ of an inch long, of a red colour, but the whole, when protruded, was above an inch long; and they could eaſily be retracted by the help of large muſcles, that were faſtened to them, and did run along under them, and were at laſt inſerted at the end of the tail, and joining of the firſt rattle, and they may be called *Retractores Penum*; there are ſeveral animals that have no *Penis* at all, only *Vaſa Deferentia*, as moſt fiſhes; all quadrupeds have but a ſingle *Penis*; ſome birds have only one; moſt others, if they may be ſaid to have any, have two, but thoſe very ſhort; crabs, lobſters, &c. have two long ones, one on each ſide; but earth-worms, leeches, ſhell-ſnails, &c. are hermaphrodites, and have the perfect organs of both ſexes; but why the rattle-ſnake, or male viper, ſhould have four *Penes*, when the female has but two *Uteri* for receiving them, is hard to account for; it ſeems probable, that they have the *Penis* on each ſide double or forked, that when they are entred the *Uteri*, by ſpreading themſelves like the *Pythagorean* Y, they may the better and more firmly be retained there till they have performed their office; and this too ſeems to be one uſe of the *Aculei* or briſtles towards the root; for having their points looking backwards, when once they have entred the *Pudendum*, they muſt needs lock them in, and retain them there, till ſuch time as the parts being tired and ſubſiding, have leave to retreat; for in animals, which have no *Veſiculæ Seminales*, it is requiſite that the *Coitus* be long; that ſo the ſeed, which cannot quickly, may yet leiſurely be tranſmitted from the *Teſtes*; ſo in dogs which have no *Veſiculæ Seminales*, near the root of the bony *Penis* is a large body conſiſting of many cells and veſſels, which upon the ruſhing in of the blood and ſpirits, is ſwelled to that degree, that it forcibly retains it, till the impetus is over, and the part ſubſides; ſo the lump-fiſh has on its breaſt a large round body curiouſly contrived, like the tail of a leech, by which it can firmly adhere to the female, tho' its *Penis* be but ſhort; cats, lions, *&c.* which have likewiſe very ſhort *Penes*, that they may the better cling, are forced to make uſe of their teeth and claws; and from the pain theſe cauſe, and not from the ſcalding of the ſeed, proceed thoſe hideous ſkrieks and howlings.

The head was but ſmall, yet the *Rictus*, or mouth, was very large; the tongue in all reſpects was like that of a viper, and compoſed of two long round bodies, contiguous and joined together from the root two thirds of its length; they are darted out, and retracted again with great agility; and the part that was exerted appeared of a black colour, whereas that which lay ſheathed within was red; for it was faſtened below the throat, and from thence it was covered with a *Vagina* or ſheath to the place where it iſſues out, which was near the end of the *Larynx*; and to promote its exertion, the under jaw was here divided, leaving a conſiderable ſpace between; for if it were conjoined as in other animals, and beſet with teeth, they would be apt to injure the tongue; or at leaſt, it might prove incommodious to the uſe it is deſigned for, which with *Charas* Dr. *Tyſon* ſuſpects to be the catching of flies, and other ſmall animals they have a mind to devour: Over the tongue lay the *Larynx*, not formed with that variety of cartilages, as is uſual in other animals; but ſo as to form a rim or ſlit for receiving or diſcharging the air; there was no *Epiglottis* for preventing foreign bodies from getting in, this being ſufficiently provided for by their ſtrict cloſeneſs; and the air paſſing only thro' ſuch a ſlit, without the contrivance of other parts for modulating it, can only make ſuch a ſound as we obſerve in their hiſſing.

The teeth are of two ſorts. 1. The leſſer which are ſeated in each jaw, and ſerve for the catching and retaining their food. 2. The poiſonous fangs which kill their prey, and are placed without the upper jaw, and they are all *Canini* or dog-teeth; for ſince they neither chew nor bruiſe their food, but ſwallow it whole, they have no need of *Molares:* Of the firſt ſort of teeth, there are in the lower jaw two rows on each ſide, and five in a row, the inward leſſer than the outward, and in all twenty; in the upper jaw are only ſixteen, five on each ſide placed backwards, and ſix before, and theſe do no harm: The fangs are placed without the upper jaw towards the fore part of the mouth, and not faſtened to the *Maxillæ* as the other teeth, but to the muſcles or tendons, except the two outmoſt and largeſt fangs, which were fixed to that bone, which may be taken for the ear-bone; theſe fangs, or larger teeth, were not to be perceived upon firſt opening the mouth, for they lay flat under a ſtrong membrane or ſheath, but they could upon occaſion make them erect; they were hooked, and bent like the teeth of a *Barbaroſſa*, and ſome of the ſmalleſt were bent at right angles: In all theſe teeth, eſpecially the larger, there was obſerved a pretty large *Foramen*, or hole towards the root, and towards the point there was a manifeſt large ſlit, and from the ſlit to the root they were perfectly hollow, which was diſcovered by gently preſſing with the finger the ſide of the gum; for then the poiſon did readily ariſe thro' the hollow of the teeth, and iſſued out at the ſlit: This poiſonous liquor was obſerved to be of a water colour lightly tinged with yellow.

Amongſt the bones of the head, the *Cranium* was obſerved entire, and without ſutures, except where ſome other bones were joined to them, as forwards over the noſtrils there were two ſmall bones, to which were faſtened the cartilages, or rather bones, which divided the noſe; the other bones ſeemed admirably contrived for the great extenſion and widening of the *Maxillæ*, which ſeems to be a particular proviſion of nature, becauſe it ſwallows every thing whole, and its head is but ſmall; the upper jaw was joined forwards to the bone that receives the poiſonous fangs, with a large cavity in it, which opened externally, and was thought to be the *Foramen* of the ear, but internally no perforation was obſerved for a nerve; this articulation ſeems advantageous both for the motion of the fangs, which lie ſometimes flat, and ſometimes erect, as alſo for the motion of the jaw; but its principal and moſt remarkable advantage for ſwallowing large bodies, is the curious articulation of the *Maxillæ* backwards to the *Cranium* by two bones, which from their uſe may be called *Maxillarum Dilatatores*; their ſhape, bulk, and fitneſs for this motion will readily enough be conceived by the eye; for the lower jaw is not conjoined at the chin, as is uſual in other animals, but ſeparated to a good diſtance; upon the receiving a large body, as the membrane to which they are faſtened eaſily extends itſelf, ſo by lifting up, as alſo by bringing theſe two bones more to a ſtreight line, the mouth muſt needs be conſiderably widened; this articulation of the *Dilatatores*, with the upper and lower jaws, makes thoſe protuberances of the head reſemble a bearded arrow; the lower jaw of each ſide was compoſed of two bones, but firmly conjoined; the fore-bone received the ſmall teeth, the hind-bone towards the articulation grew broad, as did likewiſe the bone of the upper jaw anſwering to this piece in the lower; but this upper jaw, towards the poiſonous fang, divided into two bones; one was faſtened to the bone of the poiſonous fang externally; the other, which received the ſmall teeth, was inſerted into the ſame bone more internally.

The *Vertebræ*, according to the figure of the whole body, were ſmalleſt towards both extreams, and largeſt in the middle; from the neck to the *Anus*, there were as many obſerved as there were ſcales on the belly, *viz.* 168; but from the *Anus* to the ſetting on of the rattle, there were 29 more in number than the ſcales: The former *Vertebræ* had a flat upright ſpine towards the back, and a ſlender round oblique one deſcending internally towards the belly; beſides thoſe ſpines, there were other proceſſus's for the articulation of the ribs; but what was moſt remarkable, was the round ball in the lower part of the upper *Vertebræ*, which entred a ſocket of the upper part of the lower *Vertebræ*, in the ſame manner as the head of the *Os Femoris* does the *Acetabulum* of the *Os Iſchii*; by which contrivance, as alſo their articulation with each other, rattle-ſnakes have that free motion of winding their bodies every way: The ribs in the neck were ſmall, but larger towards the middle of the body, where they were about two inches long; but towards the tail they grew ſmaller and ſhorter, and did all terminate at the beginning of the ſcales of the belly: In the *Vertebræ* of the tail internally were two ſpines; whereas, in the other *Vertebræ* there was but one; and there were likewiſe tranſverſe ſlender *Proceſſus's* ſomething analogous to ribs: To the laſt *Vertebra* of the tail, the rattle was faſtened; in this ſubject there were but five, but ſome others ſeemed to be broken off; that next the tail was of a lead colour, the others of a cineritious colour; this rattle, according to *Gulielmus Piſo*, was given it by nature to be a warning both to man and beaſt to avoid the approaching danger; ſome authors aſſert, that every year there is an addition of a new rattle, ſo that this animal muſt live 16 or 20 years, for ſo many rattles have been obſerved;

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ſerved; theſe are placed with their broadeſt part perpendicular to the body, and not horizontal; and the firſt is faſtened to the laſt *Vertebra* of the tail, by means of a thick muſcle under it, and by the membranes that conjoin it to the ſkin.

Explication of the figures: Fig. 1. Plate VI. *a a a* the *Aſpera Arteria*, or wind-pipe; *B* the upper part of the lungs, which is veſicular; *c c c c c* the lower part of the lungs, forming a large bladder; *d* the firſt ſwelling of the *Oeſophagus*, or the firſt falſe ſtomach; *e e e* the *Oeſophagus* or gullet, and that part of it where it is ſtraiter; *f* the ſecond ſwelling of the *Oeſophagus*, or the ſecond falſe ſtomach; *g* the true ſtomach; *h* a ſhort ſtraitning of the gut, a little below the *Pylorus*; *i* the inteſtines; *k* the heart; *l* the auricle; *m m m* three arteries, whereof there are two aſcending, and one deſcending; *n n n* three large veins, whereof two are deſcending, and the third aſcending, which laſt ſeems to divide the liver into two lobes; *o o* the liver; *p* the gall-bladder; *q* the ſpleen, as it is called by the ancients, but by *Charas* the *Pancreas*; *r r r* a large blood-veſſel running thro' the middle of the ſcales of the belly; *s s* the muſcles belonging to the ſcales of the belly.

Fig. 2. *a* the inteſtines; *b* the gall-bladder; *c* the *Ductus Bilarius*, that paſſes thro' the middle of the ſpleen, or as it is called by *Charas*, the *Pancreas*, and enters the large gut; *d* the ſpleen or *Pancreas*; *e e* the inteſtines which were very large and winding, but ſhort; *ff* the *Rectum*; *g* the *Anus*; *h h* the *Teſtes*; *i i i i* the *Vaſa Deferentia*; *k k* the *Penes* on each ſide, which at the root are conjoined and thick ſet with briſtles; *l l* the muſcles which retract the *Penes*; *m m* the ſcent-bags; *n n* a large blood-veſſel, running on one ſide of the left kidney; *o o o* the emulgents ariſing from the ſame; *p p p* the ſecretory veſſels; *q q* the large blood-veſſels of the right kidney; *r r r* the emulgents ariſing from it; *s s s* a round body of blood-veſſels; *t t t* ſecretory veſſels; *u u* the *Ureters*.

Fig. 3. *a* the *Vas Deferens*, which afterwards divides, and runs to the end of the *Penes*; *b* the *Penes*; *c* the muſcles which retract the *Penes*.

Fig. 4. *a a a a* the *Aſpera Arteria* divided in the middle; *b b b* ſome larger branches of blood-veſſels; *c c c* the veſicles or cells of the lungs.

Fig. 5. *a* the hole of the noſtrils; *b* the *Foramen* leading to a large cavity, which has no perforation internally for any nerve, yet it is ſuppoſed to be deſigned for hearing; *c c* the ſmall teeth in the upper jaw; *dd* the large fangs, or poiſonous teeth; *eee* the place where the bladders of poiſon lie; *f* the *Larynx*; *g* the forked tongue; *h* the teeth in the lower jaw; *i* the place where the lower jaw is divided at the *Mentum* or chin.

Fig. 6. *a* the *Cranium* without any ſutures; *bb* the orbits of the eye; *cc* two ſmall bones over the noſe; *d* the griſly, or rather bony *Septum* of the noſe; *ee* a ſmall bone lying between the *Cranium*, and that bone, in which is fixed the poiſonous fang; *ff* a cavity in that bone, to which is faſtened the poiſonous fang, whoſe outward orifice is repreſented Fig. 5. by the letter *b*, and is thought to be the ear; *g* the large poiſonous fang, which is faſtened to the ear-bone; *h* the other poiſonous teeth, which are not fixed in the bone, but to the muſcles; *ii* the upper *Maxilla*, which contains the ſmall teeth; *kk* one ſide of the lower jaw, with its double row of teeth, which in the middle ſeems to be joined with a ſuture; *l* the diſtance at the *Mentum*, between the two ſides of the lower jaw; *mm* where the two jaws are joined together backwards, and by a tendon faſtened to another bone, which from its uſe, and for diſtinction ſake, are called *Dilatatores Maxillarum*; *nn* the *Dilatatores* of the jaws; *oo* a ſhort bone which joins the dilatators to the ſkull or *Cranium*; *p* the *Vertebræ* of the neck: Fig. 7. repreſents the poiſonous teeth.

Fig. 8. *a* the outward ſpine of the *Vertebræ*, which is flat lengthwiſe; *b* the inward ſpine of the *Vertebræ*, which is round; *c* a large flat *Proceſſus* for the articulation of the *Vertebræ*; *d* ſmall tranſverſe *Proceſſus*'s for the articulation of the ribs; *e* a round ball, like the head of the *Os Femoris*, which enters a ſocket of the lower *Vertebra*, as that does the *Acetabulum* of the *Os Iſchii*.

Fig. 9. *a* the ſpine towards the back; *bb* the two inward ſpines; *cc* the tranſverſe ſpines, analogous to ribs.

Fig. 10. *a* the *Vertebræ* of the tail; *b* the muſcle on which the rattle is faſtened: Fig. 11. exhibits a ſingle rattle, which has three joints; the firſt and largeſt appears when conjoined with others; the other two ſerve for the faſtening on the ſucceeding rattles, and are covered by them: Fig. 12. ſhews the five rattles as joined together.

M. Huygen's *Theory of the fourth* Satellite *of* Saturn, *corrected by Mr.* Edm. Halley. Phil. Tranſ. N° 145. p. 82.

AFTER Mr. *Halley* had frequently obſerved with a 24 foot teleſcope the fourth ſatellite of *Saturn*, which had been firſt diſcovered by M. *Huygens* in 1655, he perceived that M. *Huygen's* numbers were conſiderably run out, and about fifteen degrees in twenty years too ſwift, this made him reſolve to enquire more nicely into its period: Therefore in 1682 *Nov.* 13. 13 h. 00 min. *p. m.* the ſatellite appeared on the north ſide of *Saturn*, and a perpendicular let fall from it on the tranſverſe diameter of the ring, fell upon the middle of the dark ſpace of the following *Anſæ*; and the ſame night 19 h. 00 m, it had paſſed the conjunction, and the perpendicular fell exactly on the weſtern edge of the globe of *Saturn*; the northern latitude and retrograde motion made it evident, that the ſatellite was then *in perigæo:* Again *Nov.* 21, 16 h. 15 m. this ſatellite of *Saturn* was on his ſouth-ſide; the perpendicular on the line of the *Anſæ* fell on the middle of the dark ſpace of the weſtern *Anſæ*, and the ſame night 19 h. 00 m. the perpendicular fell preciſely on the centre of *Saturn*, and the diſtance from it was ſomewhat leſs than one diameter of the ring; by this it was evident that the ſatellite was *in Apogæo:* He obſerved it again *in Apogæo* on the 24th of *Jan.* 1683 at 8 h. 00 m. *p. m.* the perpendicular on the line of the *Anſæ* fell exactly on the weſtern limb of the globe of *Saturn*, and at 9 h. 30 m. *p. m.* the ſaid perpendicular fell within the globe more than half way to the centre, and the diſtance from the line of the *Anſæ* towards the ſouth, ſeemed much about one diameter of the ring: Laſtly *Feb.* 9. 1683, 8 h. 10 m. *p. m.* it was again in *Apogæo*, and he could by no means diſcern towards which ſide it inclined moſt, nor whether the tranſverſe diameter of the ring, or the diſtance of the ſatellite from it were the greater; ſo that at that time it was preciſely in *Apogæo:* He choſe two of the moſt accurate obſervations of M. *Huygens* to compare with theſe; the firſt made 1659 *March* 14, N. S. 12 h. 00 m. at the *Hague*; when the ſatellite appeared about one diameter of the ring under *Saturn*; but it was gone ſo far to the weſtward, that he concluded that about four hours before, or 7 h. 40 m. at *London* it had been in *Perigæo:* Again, *March* 22d, 1659. 10 h. 45 m. the ſatellite was a whole diameter above the line of the *Anſæ*, and the perpendicular thereon fell nearly upon the extremity of the eaſtern *Anſæ*.

By the firſt of Mr. *Halley*'s obſervations it appears, that the ſatellite was in *Perigæo* 1682 *Nov.* 13th, 17 h. 00 m. nearly, at which time *Saturn* was 3 ſ. 29° 39′ from the firſt ſtar of *Aries* in the ecliptic; but the earth reduced to *Saturn*'s equinoctial, and the ſatellite was 9 ſ. 23° 46′ from the firſt ſtar of *Aries*; and *March* 4, 1659, 7 h. 40′ *Saturn*'s place in the ecliptic was 6 ſ. 0° 41′; but the earth reduced and conſequently the ſatellite, in 11 ſ. 28° 18′ from the firſt ſtar of *Aries*: The interval of time is 8655 days, 9 h. 20′ in which the ſatellite had made a certain number of revolutions to the fixed ſtars, and beſides 9 ſ. 25° 28′, or 295°, 28′ whoſe complement to a circle 64° 32′ is two days, 20 h. 36′ motion of the ſatellite according to *Huygens*; ſo that 8655 days, 5 h. 56′ or 12467876 minutes of time, the time of ſome number of entire revolutions; and dividing that interval by fifteen days, 22 h. 39′ or 22959′ the period of *Huygens*, the quotient 543 ſhews the number of revolutions; and again dividing 12467876 by 543, the quotient 22961 $\frac{1}{10}$ m. or 15 days, 22 h. 41′ 6″ appears to be the true time of this ſatellite's period; hence the diurnal motion will be 22° 34′ 38″ 18‴, and the annual, beſides 22 revolutions, 10 ſ. 20° 43′: Mr. *Halley* having made tables to this period, found that in the *Apogæon* obſervation of *Huygens*, the ſatellite was above 3 degrees faſter than by his calculation, and that in the three other obſervations of his own, it being likewiſe in the ſuperior part it was $2\frac{1}{2}$ degrees ſlower than by the ſame calculation; now it is evident, that the differences muſt ariſe from ſome eccentricity in the orbit of this ſatellite, and that in *March* 1659 the *Apocronion* or greateſt diſtance from *Saturn* was ſomewhere in the oriental ſemi-circle; and that in *Nov.* 1682 it was in the weſtern ſemi-circle; and ſuppoſing the *Apocronion* fix'd, it muſt neceſſarily be between 9 ſ. 23° 46, and 11 ſ. 28° 18′ from the firſt ſtar of *Aries*, that being the common part between thoſe two ſemi-circles; and becauſe the difference was greater in *Huygen*'s obſervation than in Mr. *Halley*'s, it will follow that the *Linea Apſidum*, or *Apocronion* ſhould be nearer to 9 ſ. 23° 46′, than to 11 ſ. 28° 18′, Mr. *Halley* ſuppoſes it 10 ſ. 22° 00′ from the firſt ſtar of *Aries*, which alſo happens to be the place of *Saturn*'s equinox, and the greateſt equation about $2\frac{1}{2}$ deg. Upon account of this inequality, the mean motion of the ſatellite will be found about 2°

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45′ ſlower in 23½ years, or 7′ in a year; whence Mr. *Halley* ſtates the annual motion 10 ſ. 20° 36′, above 22 revolutions, and the correct epocha for the laſt day of *December* 1682, at noon in the meridian of *London* 9 ſ. 10° 15′ from the firſt ſtar of *Aries*; from theſe elements tables may be calculated.

A Murrain *in* Switzerland *and its Cure*; *by Dr.* Wincler.

Phil. Tranſ. N° 145. p. 93.

IN 1682 on the borders of *Italy* a murrain infected the cattle which ſpread into *Switzerland*, the territories of *Wirtemberg*, and other provinces, and made great deſtruction among them; the contagion ſeemed to propagate itſelf in the form of a blue miſt, which fell upon thoſe paſtures where the cattle grazed, inſomuch that whole herds returned ſick home; being very dull, and forbearing their food, moſt of them would die in twenty four hours; upon diſſection, there were diſcovered large and corrupted ſpleen, ſphacelous corroded tongues, and ſome had malignant *Angina*'s: Such perſons as unwarily managed their cattle, without regarding their own health, were themſelves infected, and died like their beaſts: This contagion may probably proceed from ſome noxious exhalations emitted from the earth in three diſtinct earthquakes that had been felt in the ſpace of one year.

The method of cure was this; upon the leaſt ſuſpicion of contagion, the tongue of the animal was carefully examined; if they found any *Apthæ* or bliſters of whatever colour they were, they rubbed and ſcratched the tongue till it bled; then they wiped away the blood and corruption with new unwaſhed linnen; this done, a lotion of ſalt and good vinegar was uſed for the tongue: The antidote and medicine for the diſeaſed cattle was the ſame; *viz.* take of ſoot, gunpowder, brimſtone and ſalt, equal parts, and as much water as is neceſſary to waſh it down; give a large ſpoonful for a doſe.

Dr. *Slare* was aſſured by two ingenious travellers that this contagion reached the borders of *Poland*, having paſſed quite thro' *Germany*; that it was obſerved to advance daily, ſpreading near two *German* miles in 24 hours; that it did at the ſame time infect places at great diſtances; that cattle ſecured at rack and [illegible]nger were equally infected with thoſe in the field.

The Formation of Salt *and* Sand *from* Brine; *by Dr.* Rob. Plot. Phil. Tranſ. N° 145. p. 96.

UPON ſtraining a competent quantity of the brine from the pits in *Staffordſhire* thro' eight folds of fine holland, and as many of cambrick, there was nothing found in this cloſe colander but a little black duſt, which might be owing to the foulneſs of the water, it being nothing like ſand; for having examined the cloth both with the fingers and a microſcope, no ſand could be obſerved; and yet this brine is found to hold in boiling at leaſt ¼ as much ſand as ſalt: But, notwithſtanding this experiment, it did not ſeem neceſſary to ſuppoſe that the ſand was generated in the boiling, but might rather be originally there; for, previous to the ſtraining of it, there was obſerved in the water, by the help of a microſcope, a great number of very minute animals, much ſmaller than thoſe in pepper-water, ſwimming about in it, together with many ſmall tranſparent plates, ſome a little bigger than the *Animalcules*, and ſome leſs; but all of a rectangular oblong figure, tho' ſome nearly reſembled a ſquare, and they were found in the water after ſtraining as thick as before, the pores or rather interſtices between the threads of the cambrick and holland appearing in the microſcope twenty times greater than either the *Animalcules* or plates; and theſe were judged to be the original particles both of the ſalt and ſand; which, as the water evaporates in boiling, might gather together, till they made up ſuch a viſible coarſe body, as the greater corns of each are; and this ſuſpicion was confirmed in a little time; for obſerving with an excellent microſcope ſome of the ſtrong brine, which drops from the baſkets or barrows, when the ſalt is firſt put into them, tho' at firſt it looks like clear water, yet upon a more accurate obſervation it appeared exceeding full of theſe oblong particles, which were perceived to unite and gather together to form larger parcels; and as the water dried off from the glaſs, to grow ſtill larger, till they appeared as big, and nearly reſembling a large ſized table diamond; which afforded a ſuſpicion that the ſand might be alſo generated in the ſame manner; it appearing to be only an inſipid ſalt, conſiſting of parts not ſo ſharp pointed as the other, but rounder and blunter angled, and conſequently not ſo pungent on the tongue; yet this ſand could not be made to diſſolve to any conſiderable quantity; and tho' the ſalt would diſſolve, yet it did not form itſelf again into plates: Upon obſerving ſome of the ſalt made at thoſe pits, before it was dried and beaten ſmall, many of the larger corns appeared of the ſame ſhape to the naked eye, that the minute ones did in the microſcope; and they evidently conſiſted of a great number of ſmall plates, ſhooting up from a quadrangular oblong baſe into a very obtuſe pyramid, and hollow within.

The Lumbricus Latus; *by Dr.* Edw. Tyſon. Phil. Tranſ. N° 146. p. 113.

THE *Lumbricus Latus* is a flat worm, and hence its denomination; it was called by *Hippocrates Tænia*, and hence by ſome in *Engliſh*, the tape-worm; this flatneſs of its body ſufficiently diſtinguiſhes it from the other, which are uſually bred in the body; and are either ſhort and ſmall, and then called *Aſcarides*; or longer, as the *Teretes*; the breadth of the *Latus* is various both in the ſame worm and in different worms; the longer the worm is, the broader uſually are the latter joints; and theſe joints are ſo articulated, that the extreme edges of the preceeding come over the ſubſequent; and this may be a direction for finding which end is the head; and theſe edges in ſome are obſerved to be plain and ſmooth; in others jagged, and indented in all; by ſlipping it thro' the fingers from the tail to the head, you will find a great roughneſs; but if the contrary way, it ſeems ſmooth: The extremity whereon the head is ſet is ſmaller than the other, and ſometimes not half a quarter ſo broad, the joints towards the head are vaſtly ſhorter than towards the tail; ſo that the joints ſeem to encreaſe gradually, both in length and width, as they approach the tail; but withal it muſt be obſerved, that according to the corrugation or extenſion of thoſe joints, their dimenſions will be altered, which is very manifeſt when they are alive; there is likewiſe a great difference in their joints; *viz.* that in moſt, the joints do gradually and very ſenſibly increaſe in length; in ſome, thoſe orifices which Dr. *Tyſon* takes for mouths were placed about the middle of the joints on the edges; in others, about the middle of the flat of the worm near the jointings; theſe juttings, or lips of the upper joints over the lower, were plain in ſome, in others jagged, in others again the great protuberances at the ſide rendred the whole worm indented; generally the ſame joint is much of a bigneſs throughout, but the upper extremity is ſomething ſmaller than the lower: This worm lies folded up in ſeveral places, and is ſometimes as long as the whole guts, and ſometimes it vaſtly exceeds that length; *Olaus Borrichius* tells us of a patient of his, who voided 800 foot of this ſort of worms in ſeveral pieces in a year's time, and that hitherto he had not met with the head; for the patient obſerved, that always in the voiding it, he perceived it break off: Dr. *Tyſon* himſelf had an inſtance of a patient, who had voided vaſt quantities of this worm for ſeveral years together, but in ſeveral pieces from two to ſix or more yards in length, which all put together would much exceed the length of that of *Borrichius*: But tho' the length of this ſpecies of worms cannot be aſcertained, yet it is undeniable, that it is vaſtly long, as plainly appears by thoſe pieces that were exhibited; and Dr. *Tyſon*, meaſuring one voided by a young man about 20 years of age, found it 24 foot long, and he numbred 507 joints therein; its colour was extreme white, being turgid with chyle; its body was flat about the thickneſs of half a crown where thickeſt; and the joints towards the tail were about ¼ of an inch broad; thoſe towards the head about ¼ as broad as thoſe towards the tail; and the joints were not ¼ of an inch long, whereas thoſe at the tail were a full inch and more in length, and they ſeemed gradually to grow longer from the head; the joints were much of a width throughout; and the jutting edges of the preceeding joints over the ſubſequent were uſually plain and even; unleſs where the contraction of the body had crimpled them a little: The flats of both ſides were exactly alike, and without any ſpots, protuberances, or any thing remarkable, which might diſtinguiſh them, only a ſmooth ſurface; but about the middle of the edges of each joint Dr. *Tyſon* obſerved a protuberant orifice, which would eaſily enough admit a hog's briſtle, and was open and manifeſt to the naked eye; theſe orifices were for the moſt part placed alternately; in one joint on the right ſide, in the following on the left; and ſometimes he obſerved them in two, but more rarely in three ſucceeding joints of the ſame ſide, and never in one joint more than once; theſe orifices he takes for ſo many mouths.

Theſe worms are only to be met with in the animal kingdom, and that in ſeveral ſubjects, and thoſe of different ſpecies; they are very frequent in fiſhes, as pikes, whitings, bleaks, crabs, herrings, *&c.* and upon this ſcore they ſometimes prove a great damage to the merchants, who, as *Platerus* obſerves, are forced to fling them away; if in ſummer you open thoſe bleaks that leap and tumble in the water, from the pain they feel within, you will almoſt conſtantly meet with this worm; they are alſo often obſerved in oxen; in calves not ſo much; but in dogs very frequently.

The head of this worm is very obſcure, and has given riſe to many diſputes amongſt anatomiſts, who are ſtill forced to own that they are at a loſs, and know nothing certain about it; but Dr. *Tyſon*, having opened a dog, found a worm alive in the *Ileon*, not lying ſtreight, but in folds in ſeveral places; and he traced it up to the ſmalleſt extremity in the *Duodenum*, where he expected the head to be, the broader end being towards the *Rectum*, which was looſe and did not adhere; but the ſmaller extremity ſtuck ſo firmly to the inner coat of the inteſtine, that it was looſened with ſome trouble; it would ſometimes ſhoot out this head a conſiderable length, and again retract it, and thus alter its figure very much, by becoming broader; upon viewing this with a good microſcope, it appeared thick beſet with two rows of ſpikes or hooks, the larger of which aroſe from the centre, ſpreading themſelves over the edges of the circumference; the other, which were ſmaller and ſhorter, iſſuing out about the middle, more towards the edges; but by the ſtricteſt inquiry no orifice could be obſerved; and it was ſuggeſted by ſome ingenious perſons that theſe hairs or ſpikes might reſemble the ſmall feet of the tick, for faſtening itſelf the better to help its ſuction; and indeed were blood the food it lived upon, the caſe would be plain; but ſince it is chyle, what ſervice they can be of, is not ſo eaſily perceived; but what ſeems moſt probable is, that by the means of theſe hooks and ſpikes, it faſtens itſelf, and ſo prevents it a too eaſy ejection out of the body; for it being ſo very long, and large too, and its body in many places winding and convoluted, the deſcent of the *Fœces* upon all occaſions would be apt to carry it out with them, had it not this hold; which is ſo firm, that rather than quit it, parts of its body are broken off: When it penetrates the coats of the inteſtine, it draws in its hooks and contracts its head to a point; then it expands them, and takes firm hold of the membrane, by darting its ſeveral poinards into it; which cauſes thoſe intolerable pains, which thoſe patients that are ſo much troubled with them do complain of, and hence it is that the cure is ſo difficult, that tho' at times vaſt quantities may be brought away, yet ſome can hardly ever have a perfect cure.

It has been already obſerved that the orifices in the joints are of two ſorts, being placed in ſome on the edges in the middle of the joints, often alternately, in one joint on the right hand, in the other on the left, ſometimes in two, ſeldom in more on the ſame ſide; they are protuberant ſomething like *Papillæ* or nipples, with a hole in the middle eaſily enough perceiveable by the naked eye, and readily admitting a hog's briſtle; in the other ſort, theſe protuberances are placed about the middle of the flat of the worm, towards the upper part of the joint, and are what authors mean by their *Maculæ Nigricantes:* Dr. *Tyſon* chiefly inſiſts on the former ſort, and that theſe are ſo many mouths he firſt argues from the great quantity of chyle they are often turgid with; ſecondly, from the great appetite of the patient, but more often from the thirſt, and almoſt continual emaciation which they cauſe; thirdly, that no other mouth beſides is obſerved; fourthly, that no uſe can be ſo fitly aſſigned thoſe orifices as that of mouths: As to the firſt, none who have obſerved them but muſt own that they are often very turgid, as that which Dr. *Tyſon* had of eight yards in length, did very plainly ſhew, and ſpirit of wine, into which it was put, became muddy, by its diſcharging a large quantity of a chylous juice, which made a deep ſediment at the bottom, as it alſo did a ſecond time after putting it into freſh ſpirits; now whence all this could iſſue, but by theſe orifices on the ſide is not eaſily accounted for; and being ſo large in quantity, it could not otherwiſe be well received into the body, but by theſe many mouths, which being always open and lying on all ſides do greedily devour the beſt part of the chyle and nutritious juice. 2. Hence may be well accounted for that *Appetitus Caninus*, great thirſt and atrophy, mentioned under the ſecond particular, and which are often obſerved in thoſe that are afflicted with this worm; which could not be effected unleſs they had many mouths, whereby they rob the lacteals of their chyle, and whence neceſſarily enſues an extenuation of the body. 3. If theſe orifices be not allowed to be ſo many mouths, we muſt be at a loſs where to find them in the whole body beſides; for in that part called the head none can be diſcovered by the microſcope, and if there be any in that place it muſt be conſiderably too ſmall; and being ſo, and but ſingle too, it is not eaſy to account how it can take in ſo great a quantity of chyle, neceſſary for a body of ſo great a length: 4. If theſe orifices be not allowed to be mouths, it is hard to account what elſe they are; they cannot be taken for ſo many *Anus*'s or vents for their excrements; ſince it is pure chyle they feed upon, which will not afford much, at leaſt not ſo groſs an excrement, as to need ſo many and large orifices for diſcharging it; it is eaſier to imagine them

Bronchiæ or lungs, which in inſects are obſerved in all the *Annuli*, or joints of the body; but with this difference, that in them you will conſtantly ſee theſe orifices on both ſides in each *Annulus*, but in the worm never but on one ſide; nor are they near ſo open and large in the former as in the latter, whence the chyle muſt ſlip into them, and ſo ſpoil them for being lungs; to which may be added, that the joints when broken off do ſtill live, which they could not do unleſs they had mouths in each.

It has been ſtiffly maintained by authors of great note, both modern and ancient, that the worm itſelf ſcarce lives, being only a *Spolium* or ſlough of the inteſtine; or at leaſt, is not one, but many worms included in that membrane; but ſuch opinions ſeem wide of the truth; for many phyſicians have obſerved it to move, and conſequently to be alive; and Dr. *Tyſon* had a remarkable inſtance of it in the diſſection of a dog, where he particularly obſerved the manner of its performing its motion; for tho' all was done by contracting and ſhortening the joints, yet ſometimes it became round and cylindrical, tho' naturally flat; at other times it formed a deep concave on one ſide, and a convex on the other; but moſt times there was a bellying out at the edges, about the middle of the joints; and tho' that part towards the head was very ſlender, yet upon contraction it would become as broad as the laſt joints; this contraction he ſometimes obſerved at once in ſeveral parts at ſome diſtance from each other, which muſt needs much promote its progreſſive motion; ſince being of ſo great a length, it otherwiſe could make but little progreſs; which is perhaps requiſite that it may recover itſelf, when the deſcent of the fœces drive it downwards; and for promoting its motion, there is a prominence at every joint of the ſuperior over the inferior, which, like ſo many ſcales on the bellies of other reptiles, do perform the office of feet: Again, ſome authors who admit this worm to be alive, aſſert that it is not one, but many worms linked together, and included in a *Spolium* or ſlough of the inteſtines, and that this *Spolium* itſelf is not animated, but receives all its ſenſe and motion from the *Cucurbitini*, or ſmall worms like cucumber-ſeeds included in it; but Dr. *Tyſon* ſuſpects this particular very much, becauſe a joint or two fell off from the worm in the dog, and he did not obſerve any membrane hanging to the preceeding joint, out of which it might ſlip, but it broke off entire; and the ſetting on of the joints is ſuch, that it ſeems ſufficient to ſhew, that this worm cannot be a continued membrane articulated only by the ſeveral *Cucurbitini* included therein, ſince there is ſo large a protuberance of the lower extremity of the preceeding joint over the upper part of the following: If this worm be only a membrane, why is there conſtantly, and that regularly a difference of both extremities, as to their length and breadth? How happen the hooks at the head? How are theſe orifices formed at the edges, or on the flat of the worms? But that all thoſe ſingle joints, whilſt in the body, do live, appears not only from their mouths for receiving their food, and no doubt correſponding organs for the digeſtion and diſtribution thereof, but alſo from this, that both ſingle joints, and often larger pieces have been voided alive, and ſeveral pieces Dr. *Tyſon* obſerved equally turgid and filled with chyle in proportion to the magnitude of the parts: Upon the whole, there may be ſome analogy between this jointed worm and knotted plants, whoſe each joint can ſo eaſily propagate itſelf; and it may be thought to be an *Zoophyton* or plant-animal bred in animal bodies; ſince ſo large and frequent detruncations of the body do not deſtroy the life of the whole.

Explication of the figures. Fig. 13. Plate VI. repreſents a worm, or rather part of a worm, voided by a young man in *London*, which was eight yards long; the leſſer extremity is that part towards the head; the broader, the tail; the protuberances about the middle of the edges of the joints are the mouths. Fig. 14. repreſents a worm taken out of a dog, about five foot long, and alive; the ſmall end ſhews the head, as it appeared to the naked eye; the two protuberances at the ſides, are the mouths; the broad end, the tail. Fig. 15. repreſents the protuberance, or *Papilla* about the middle of the edges, as viewed with a microſcope, and in it the orifice, which is taken for the mouth of this worm. Fig. 16. is the head of this worm, as it appeared in the microſcope; wherein is obſervable a double order of ſpikes or hooks, the longeſt ariſing from the centre, the other more towards the edges, which at pleaſure it can contract and protrude. Fig. 17. a ſide proſpect of the head and its hooks.

The Lumbricus Teres, *or* Round Worm; *by Dr.* Edw. Tyſon.
Phil. Tranſ. N° 147. p. 154.

THE *Lumbricus Teres*, or round worm, with which children are uſually troubled, is by *Hippocrates* called *Strongylus*; by *Celſus*, *Teres*; it is uſually about a foot long; but the male is generally ſmaller than the female; they are about the bigneſs of a wheat-ſtraw, or a gooſe-quill, and their colour white; thoſe feet or aſperities are not obſerved on the *Annuli* or rings, as in the earth-worm; at both extremities they grow narrow; their mouth is compoſed of three lips; in the ſame manner the leech has three cartilaginous teeth ſet in a triangle, by which it wounds the ſkin in ſuction; the *Anus* is a tranſverſe ſlit a little on this ſide of the extremity of the tail: In opening the body, Dr. *Tyſon* found he cut thro' a large muſcle under the ſkin, which is ſpiral in earth-worms, as in great meaſure their motion is; ſo that by this means like the worm of an auger, they can the better bore their paſſage into the earth; their reptile motion may alſo be explained by a wire wound on a cylinder, which when ſlipped off, and one end extended and held faſt, will bring the other nearer it; ſo the earth-worm having ſhot out, or extended its body, which is with a wreathing motion, it takes hold by its ſmall feet, and thus contracts the hinder part of its body; he likewiſe obſerved, that dividing this part, there iſſued out a copious *Ichor*, which is naturally diſcharged from ſome pores in the ſkin, and is of great uſe to the earth-worm, by rendring its body ſlippery, that ſo it may the more eaſily glide into the earth; and in theſe other worms of the inteſtines, this humour, as in leeches, makes a covering to the body, which is often caſt off, and obſerved as a *Mucus* in the ſtools of thoſe troubled with them: In theſe *Teretes* of animal bodies he never obſerved thoſe tranſverſe diaphragms, which are ſo numerous in earth-worms, interſecting or rather deeply depreſſing the inteſtine; the paſſage from the mouth was ſomewhat ſtraitned for a ſhort ſpace, and was diſtinguiſhed from the following *Ductus*, which was a ſtreight inteſtine continued to the end of the body, without any winding, or other diſtinction of a ſtomach, that could be obſerved: The *Penis* in the male was placed at the tail, and ſeemed capable of exerting itſelf almoſt the length of a barley-corn, or proportionably to the length of the *Vagina* in the female; at the root of the *Penis* was inſerted the neck of the *Veſicula Seminalis*, which gradually grew larger, as it aſcended in the body, and uſually reached almoſt half way; it was filled with a milky juice, which it received from a ſlender veſſel of the ſame colour inſerted into it, which after one turning was afterwards very much convoluted, and formed the body called the *Teſtis*; and tho' this part be of ſo looſe a texture, as even to the naked eye to appear but as a continued veſſel, and to be eaſily unravelled its whole length, which was half a yard; yet it may be called a *Teſtis*, ſince it is now ſufficiently known that the *Teſtes* in more compleat animals are only a congeries of veſſels.

In the female worm, almoſt about the middle of the body, but more towards the head, Dr. *Tyſon* obſerved an orifice or *Pudendum*, which led into the *Vagina Uteri*, which ſoon divided into two large and remarkable *Cornua*; for deſcending a little winding towards the tail, they were then reflected again, and did each of them terminate in white ſlender veſſels, but much ſmaller, and lay in ſeveral convolutions and windings among them; and theſe he took for ſpermatic veſſels; having taken thoſe veſſels with the *Cornua Uteri* and *Vagina* out of the body, and laid them on a paper to dry, they meaſured from each horn to the end of the ſpermatic veſſels about four foot; he opened the *Cornua Uteri*, and found them turgid with a milky juice, and putting a little of it upon a ſmall microſcope, he plainly perceived it to be nothing elſe but an infinite number of ſmall eggs; theſe eggs, when freſh, appeared full of aſperities, but as they grew dry, their ſurface appeared ſmooth; and the number of eggs could not be leſs than 10000 eggs in each female worm, which ſufficiently accounts for that prodigious number produced in animal bodies; whence it appears, that theſe worms do both generate, and are oviparous; and were it not, that the greateſt part of the *Ovaria* of this worm is uſually carried forth by the fœces, we muſt be devoured by ſo prolific an enemy, which we breed in our own bowels; that caution thereof of *Hen. ab Heers* is neceſſary, *viz.* to avoid the giving the powder of theſe worms for expelling others, ſince we cannot be ſure, but that at the ſame time we may ſow the ſeed for propagating more.

Explication of the figures. Fig. 18. Plate VI. repreſents a male worm opened; *a* ſhews the three lips of the worm; *b* the gullet; *ccc* the large inteſtine; *d* the *Penis*; *ee* the *Veſicula Seminalis*; *f* the *Teſtis*. Fig. 19, a female worm opened; *a* the mouth; *b* the gullet; *ccc* the inteſtine, or gut; *dddd* the two *Cornua Uteri*; *e* the *Vagina Uteri*; *fff* the ſpermatic veſſels; *g* the *Anus*. Fig. 20, the genital parts of the female explicated; *a* the *Pudendum*, as it appears on the outſide of the ſkin; *b* the *Vagina Uteri*; *cc* the two *Cornua Uteri*; *dd* the ſpermatic veſſels. Fig. 21, the eggs of this worm, as they appeared in a microſcope.

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An Hydrophobia; *by Dr.* M. Liſter. Phil. Tranſ. N° 147. p. 162.

JAmes Horton of *York*, a very ſtrong and well proportioned young man, was bit by a mad dog in the right hand; the wound healed of itſelf, and the thing was forgotten; in about five or ſix weeks he complained of pain all over his bones, but eſpecially his back, and round about his ſtomach, he looked very pale, hollow-eyed, *&c.* The third day after this complaint, he called for brandy, drank it, went to bed, and vomited it up; after this he had a reſtleſs night, and in the morning found himſelf very ill, with a ſtrong riſing in his ſtomach, and tho' no thirſt, yet an inability of drinking, and even of ſwallowing his ſpittle, which was death to him as he often ſaid; *Diaſcordium*, and a bottle of cordial water were brought, he took the former, but was not able to drink one ſpoonful of the cordial; his pulſe was very ſlow, and ſometimes unequal, his fleſh cold, his tongue flexible and moiſt, and a little white; he complained very much of being ſick at ſtomach; and upon offering him a cordial, he would ſtart and tremble at the approach of it; as he alſo did at giving him water to drink, and putting it forwards to his mouth, he, the more affrighted, would draw back his head, and ſigh, and throw a very ghaſtly look upon it, not without ſhrieking and noiſe; whence it appeared, that it was an *Hydrophobia* or dread of water; upon which a vein was ordered to be opened in the bitten arm, the wound to be ſcarified and drawn with veſicatories, and the ſame plaiſters to be applied to the neck, legs, and inſide of the arms; the uſual antidotes were preſcribed, as *Theriaca*, *Cinis Cancrorum*, *Ruta*, *Agaricus*, &c. in bolus's; for he could take ſolid things in a ſpoon, yet not without much trembling, fear, and caution, and an earneſt requeſt that no body would ſuddenly offer them to him, but give them gently into his hand, and then he would ſteal them ſoftly to his mouth, and greedily ſwallow them like a dog; drink was likewiſe offered him, but he could not ſee it without horror, and the ſame diſorderly motions at his ſtomach: His blood, both as to the *Serum* and *Cruor*, was well coloured, and in ſuch proportion as is uſual in healthful perſons, and of a good conſiſtence: The patient was perſwaded with much difficulty to throw himſelf upon his belly a-croſs the bed, with his head hanging over the other ſide; in this poſture of a dog he ſuffered a large bowl filled with ſmall beer to be brought under his head, and embracing it with rapture, he declared he was infinitely refreſhed with the ſmell of it; he endeavoured with great earneſtneſs to put down his head to it, but could not, his ſtomach roſe as often as he opened his lips; at length he put out his tongue, and made towards it as tho' he would lap; but when his tongue ever ſo little touched the ſurface of the beer, he ſtarted back affrighted, and yet all the while he was pleaſed with the thoughts of drinking, and would not ſuffer it to be taken away from under his head; and if it was a little withdrawn, he would follow the ſmell of it with delight, and ſnuff at it with his noſtrils; but the patient alledging that the faint ſmell of the ſmall beer hindred him from drinking; a bowl of ale was brought him, but after much ſtriving and exerting his tongue a thouſand times, he could not drink of it; and lapping with great terror, as often as his tongue touched it, he ſtarted back with his head, bringing it down again gently to the bowl a hundred times, but all in vain; he had then a quill given him conſiſting of two or three joints, the one end in his mouth, the other in the liquor; but he could not manage it, nor ſuck any more than a dog; after this he was made to lie down, and in a little time he fell into convulſions, bit and ſnarled, and catched at every body, and foamed at the mouth; after this fit was over, he took an elleboriſm in a bolus; it wrought about three or four times very plentifully, and he declared himſelf wonderfully at eaſe, but yet now and then he would fall into convulſions, and then he was always inſenſible; ſome time after he was again ſolicited to drink, and he now readily enough put himſelf into the former poſture, and with as much earneſtneſs as ever uſed all the little ſhifts to drink, while the bowl was under his head, but all in vain; a ſmall ſilver tumbler full of drink was put into his hand, which, when he had ſtolen near his mouth, he would have thrown into his throat, but it ſtruck againſt his teeth, and fell into the bowl again: He never went to ſtool, or made water all this time, which was near 48 hours, and therefore a clyſter was given him, but he did not retain it, and after this he died convulſed; his not making water, as well as a troubleſome priapiſm he complained of when on his knees, might proceed from the bliſtering plaiſters, as well as from his diſeaſe: It is very hard to account for this *Pavor Aquæ*, or dread of water; however, to lay down ſome few things towards a ſolution of it, it is to be obſerved, firſt, that the patient had ſome of the organic parts of his body transformed into, or affected after the nature of a dog, eſpecially the gullet, tongue, &c. ſo that what was offered in the erect poſture of a man was very frightful, as well as difficult for him to take, becauſe againſt his new nature, as much as it would be for a dog to drink ſtanding upon his hinder legs; but yet this is not all, for when he was turned upon his belly, and would have acted the dog, yet he could not bear to take any liquor into his mouth; whence we may imagine, that he was either convulſed, or had a ſwelling in thoſe parts; but this cannot be the caſe, for the contrary plainly appears from his ſwallowing bolus's: Secondly, his ſpittle was envenomed; for as often as he ſwallowed it, it cauſed intolerable pain, and as the patient expreſſed it, it went to his heart; and ſo liquid things coming nearer to the conſiſtence of ſpittle might the rather promote that excretion, and therefore give a greater terror and difficulty of ſwallowing, than ſolid things; and that his ſpittle was chiefly infected with the venom of the dog, ſeems probable from theſe reaſons; 1. Becauſe the dog bit him, whoſe ſpittle alone is venomous, as appears from many credible inſtances in medical hiſtory. 2. He was almoſt like a dog in the mouth, *viz.* the place of the proper organs of ſpittle. 3. The bite of a man ſo bitten is alſo infectious, but otherwiſe innocent.

A Theory of the Magnetical Variation; *by Mr.* Edm. Halley.

Phil. Tranſ. N° 148. p. 208.

BEfore Mr. *Halley* proceeds to the theory of the variation of the compaſs, which is the deviation of the magnetical needle from the true meridian, either to the eaſt or weſt, he in the firſt place lays down the grounds, on which he raiſes his concluſions, and gives a compendious view of thoſe variations, which he had reaſon to build upon, as being moſtly the obſervations of perſons of ſkill and integrity, in the following table,

Names of Places.	*Longitude from* Lond.		*Latitude.*		*Anno Dom.*	*Variation Obſerved.*	
	deg.	m.	deg.	m.		deg.	m.
London	0	0	51	32 N.	1580	11	15 E.
					1622	6	0 E.
					1634	4	5 E.
					1672	2	30 W.
					1683	4	30 W.
Paris	2	25 E.	48	51 N.	1640	3	00 E.
					1666	0	0
					1681	2	30 W.
Uraniburg	13	0 E.	55	54 N.	1672	2	35 W.

Names of Places.	*Longitude.* deg. m.	*Latitude.* deg. m.	*Anno Dom.*	*Variation.* deg. m.
Copenhagen	12 53 E.	55 41 N.	1649	1 30 E.
			1672	3 35 W.
Dantzick	19 0 E.	54 23 N.	1679	7 00 W.
Mompelier	4 0 E.	43 37 N.	1674	1 10 W.
Breſt	4 25 W.	48 23 N.	1680	1 45 W.
Rome	13 0 E.	41 50 N.	1681	5 0 W.
Bayonne	1 20 W.	43 30 N.	1680	1 20 W.
Hudſon's Bay	79 40 W.	51 00 N.	1668	19 15 W.
In *Hudſon's* Straights	57 00 W.	61 00 N.	1668	29 30 W.
In *Baffin's* Bay, at Sir *Thomas Smith's* Sound	80 00 W.	78 00 N.	1616	57 00 W.
At Sea	50 0 W.	38 40 N.	1682	7 30 W.
At Sea	31 30 W.	43 50 N.	1682	5 30 W.
At Sea	42 0 W.	21 0 N.	1678	0 40 E.
Cape St. *Auguſtine* of *Brazil*	35 30 W.	8 0 S.	1670	5 30 E.
Cape *Frio*	41 10 W.	22 40 S.	1670	12 10 E.
At Sea off of the Mouth of the River of *Plata*	53 00 W.	39 30 S.	1670	20 30 E.
At the Eaſt Entrance of the *Magellan* Straights	68 00 W.	52 30 S.	1670	17 00 E.
At the Weſt Entrance of the *Magellan* Straights	75 00 W.	53 00 S.	1670	14 10 E.
Baldivia	73 00 W.	40 00 S.	1670	8 10 E.
At Cape d'*Agulhas*	16 30 E.	34 50 S.	1622	2 00 W.
			1675	8 00 W.
At Sea	1 0 E.	34 30 S.	1675	0 0
At Sea	20 0 W.	34 0 S.	1675	10 30 E.
At Sea	32 0 W.	24 0 S.	1675	10 30 E.
At St. *Helena*	6 30 W.	16 0 S.	1677	0 40 E.
At *Aſcenſion*	14 30 W.	7 50 S.	1678	1 00 E.
At *Johanna*	44 00 E.	12 15 S.	1675	19 30 W.
At *Mombaſa*	40 00 E.	4 00 S.	1675	16 00 W.
At *Zocatra*	56 00 E.	12 30 N.	1674	17 00 W.
At *Aden*, at the Mouth of the *Red Sea*	47 30 E.	13 00 N.	1674	15 00 W.
At *Diego Roiz*	61 0 E.	20 0 S.	1676	20 30 W.
At Sea	64 30 E.	0 0	1676	15 30 W.
At Sea	55 0 E.	27 0 S.	1676	24 00 W.
At *Bombay*	72 30 E.	19 0 N.	1676	12 00 W.
At Cape *Comorin*	76 00 E.	8 15 N.	1680	8 48 W.
At *Balliſore*	87 00 E.	21 30 N.	1680	8 20 W.
At Fort St. *George*	80 00 E.	13 15 N.	1680	8 10 W.
At the Weſt Point of *Java*	104 0 E.	6 40 S.	1676	3 10 W.

Names

Names of Places.	*Longitude.* deg. m.	*Latitude.* deg. m.	*Anno Dom.*	*Variation*
At Sea	58 00 E.	39 0 S.	1677	27 30 W.
At the Iſle of St. *Paul*	72 0 E.	38 0 S.	1677	23 30 W.
At *Van Diemens* Land	142 0 E.	42 25 S.	1642	0 0
At *New Zealand*	170 0 E.	40 50 S.	1642	9 0 E.
At Three Kings Iſle in *New Zealand*	169 30 E.	34 35 S.	1642	8 40 E.
At the Iſle *Rotterdam* in the *South Sea*	184 00 E.	20 15 S.	1642	6 20 E.
On the Coaſt of *New-Guinea*	149 00 E.	4 30 S.	1643	8 45 E.
At the Weſt Point of *New Guinea*	126 00 E.	0 26 S.	1643	5 30 E.

By this table it appears, firſt, that throughout all *Europe* the variation at this time, *viz.* 1683 is weſterly, and more in the eaſtern parts thereof than in the weſtern; as likewiſe that it ſeems to be throughout upon the increaſe that way. Secondly, that on the coaſts of *America*, about *Virginia*, *New England*, and *New-foundland*, the variation is likewiſe weſterly, increaſing all the way as you go northerly along the coaſt; ſo as to be above 20° at *New-foundland*, nearly 30° in *Hudſon*'s ſtreights, and not leſs than 57 in *Baffin*'s bay; and that as you ſail eaſtward from this coaſt the variation diminiſhes; hence he infers, ſomewhere between *Europe* and the north part of *America*, there muſt be an eaſterly variation, or at leaſt none weſterly; and ſo he conjectures it is about the eaſtmoſt of the *Tercera* iſlands. Thirdly, that on the coaſt of *Braſil*, there is eaſt variation, which encreaſes very notably, as you go to the ſouthward, ſo as to be 12° at *Cape Frio*, and over againſt the river of *Plata* 20 ½°, and from thence ſailing ſouth weſterly to the ſtraights of *Magellan*, it decreaſes to 17° and at the weſt entrance it is but 14°. Fourthly, that eaſtward of *Braſil*, this eaſterly variation decreaſes, ſo as to be very little at St. *Helena* and *Aſcenſion*, and to be quite gone, and the compaſs to point true about 18 degrees of longitude weſt from the *Cape of Good Hope*. Fifthly, that to the eaſtward of the aforeſaid places, a weſtward variation begins, and obtains in all the *Indian* ſea, ariſing to no leſs than 18 deg. under the *Equator* itſelf, about the meridian of the northern part of *Madagaſcar*; and 27 ½ deg. in 39 deg. ſouth latitude, near the ſame meridian; eaſterly from thence the weſt variation decreaſes, ſo as to be not much above 8 deg. at cape *Cormorin*, and about 3 deg. upon the coaſt of *Java*, and about the *Molucca* iſlands to be quite gone, as alſo a little to the weſtward of *Van Diemen*'s land. Sixthly, that to the eaſtward of the *Molucca*'s and *Van Diemen*'s land, in ſouth latitude, there ariſes another eaſterly variation, which ſeems not ſo great as the former, nor of ſo large extent; for at the iſland *Rotterdam* it is ſenſibly leſs than upon the eaſt coaſt of *New Guinea*; and at the rate it decreaſes, it may well be ſuppoſed, that about 20 deg. further eaſtward, or 225 deg. eaſt longitude from *London*, in the latitude of 20 deg. ſouth, a weſterly variation begins. Seventhly, that the variations obſerved at *Baldivia*, and at the weſt entrance of the *Streights* of *Magellan* ſhew, that the eaſt variation, noted in the third obſervation, is decreaſing apace, and that it cannot well extend many degrees into the *South Sea* from the coaſt of *Peru* and *Chili*, leaving room for a ſmall weſterly variation in that tract of the known world, that lies in the mid-way between *Chili* and *New-Zealand*, and between *Hound*'s iſland and *Peru*. Eighthly, that in ſailing north-weſt from St. *Helena* by *Aſcenſion*, as far as the *Equator*, the variation continues very ſmall eaſt, and as it were, conſtantly the ſame; ſo that in this part of the world, the courſe, wherein there is no variation, is evidently no meridian, but rather north-weſt. Ninthly, that the entrance of *Hudſon*'s *Streights*, and the mouth of the river *Plata*, being nearly under the ſame meridian, at the one place the needle varies 29 ½ deg. to the weſt, at the other 20 ½ deg. to the eaſt. This plainly ſhews the impoſſibility of reconciling theſe variations by Mr. *Bond*'s theory, which is by two magnetical poles and an axis, inclined to the axis of the earth; from whence it would follow, that under the ſame meridian, the variation ſhould be in all places the ſame way.

Theſe things being premiſed may ſerve as a ſure foundation to raiſe the ſuperſtructure of a theory upon; but firſt it will not be amiſs to ſhew the miſtakes of *Gilbert* and *Des Cartes*; the former whereof ſuppoſes, that the earth itſelf being in all its parts magnetical, and the water not; wherever the land is, thither alſo ſhould the needle turn, as to the greater quantity of magnetical matter; but this in many inſtances is not true, and moſt remarkably upon the coaſt of *Braſil*, where the needle is ſo far from being attracted by the land, that it turns the quite contrary way, leaving the meridian to lie N. by E. which is juſt along the coaſt. As to *Des Cartes*'s poſition, that the iron and load-ſtone hid in the bowels of the earth, and the bottom of the ſea, may be the cauſes of the needle's variation: If we conſider for how great a part of the earth's ſurface, for inſtance, in the whole *Indian* ſea, the needle declines the ſame way, and that regularly; it will follow that the attracting ſubſtance that cauſes it, muſt be very far diſtant; now by experience we find the little force that iron guns in ſhips have upon the compaſs, and experiments made before the Royal Society ſhewed, how little magnetiſm there is in moſt rude iron ores; yet it cannot be denied, that in ſome places near the ſhore, or in ſhallow water, the needle may be irregularly affected by the aforeſaid cauſes, and that not a little, as *Gaſſendus* gives a notable inſtance of the iſland *Elba* in the *Mediterranean*; but theſe differences from the general direction are always ſigns of the nearneſs of thoſe magnetical ſubſtances, for the production whereof the iſland *Elba* has been famous in all antiquity; beſides, the change of the variation within theſe hundred years laſt paſt, more than 15 deg. at *London*, is an entire demonſtration againſt both *Des Cartes* and *Gilbert*; the former does not ſtick to ſay, that the tranſportation of iron from one place to another, and the growth of new iron within the earth, where there was none before, may be the cauſe thereof: The ſame likewiſe holds againſt the hypotheſis of magnetical fibres, which *Kircher* maintains.

Now from the abovementioned obſervations Mr. *Halley* comes to this concluſion; *viz.* that the whole globe of the earth is one great magnet, with four magnetical poles, or points of attraction; near each pole of the equator, two; and that in thoſe parts of the world which lie near adjacent to any of thoſe magnetical poles, the needle is governed thereby, the neareſt pole being always predominant over the more remote: The parts of the earth, wherein thoſe magnetical poles lie, he ſays, cannot as yet be exactly determined, for want of ſufficient *Data* to proceed geometrically; but as near as conjecture can reach, he reckons that the pole, which at preſent is neareſt to us, lies in or near the meridian of the *Land's End* of *England*, and not above ſeven degrees from the *Arctic Pole*; by this *Pole* the variations in all *Europe* and *Tartary*, and the north ſea, are principally governed; tho' ſtill with ſome regard to the other northern pole, whoſe ſituation is in the meridian paſſing about the middle of *California*, and about 15 deg. from the north pole of the world; to this the needle has chiefly reſpect in all the north *America*, and in the two oceans on either ſide thereof, from the *Azores* weſtwards to *Japan*, and farther: The two ſouthern poles, he imagines, are rather farther diſtant from the ſouth pole of the world; the one about 16 deg. therefrom, in a meridian ſome 20 deg. to the weſtward of *Magellan*'s ſtreights, or 95 deg. weſt from *London*; this commands the needle in all ſouth *Amerita*, in the *Pacific* ſea, and in the greateſt part of the *Ethiopic* ocean: The fourth and laſt pole ſeems to have the greateſt power, and largeſt dominions of all, as it is the moſt remote from the pole of the world, being little leſs than 20 deg. diſtant therefrom, in the meridian which paſſes thro' *New-Holland*, and the iſland *Celebes*, about 120 deg. eaſt from *London*; this pole is predominant in the ſouth part of *Africa*, in *Arabia*, and the red ſea, in *Perſia*, *India*, and its iſlands, and all over the *Indian* ſea, from the *Cape* of *Good Hope* eaſtwards to the middle of the great *South Sea* that divides *Aſia* from *America*: This ſeems to be the preſent diſpoſition of the magnetical virtue throughout the whole globe of the earth; it remains to ſhew how this hypotheſis accounts for all the variations that have been obſerved of late; and how it anſwers to the ſeveral remarks drawn from the table: And firſt it is plain, that as our *European* north pole is in the meridian of the *Land's End* of *England*, all places more eaſterly than that, will have it on the weſt ſide of their meridian, and conſequently the needle reſpecting it with its northern point, will have a weſterly variation, which will ſtill be greater as you go eaſtwards, till you come to ſome meridian of *Ruſſia*, where it will be greateſt, and from thence decreaſe again; and accordingly in fact we find that at *Breſt* the variation is but 1 ⅓ deg. at *London* 4 ½ deg. but at *Dantzick* 7 deg. weſt: Again, to the weſtward of the meridian of the *Land's End*, the needle ought to have an eaſterly variation; were it not that (by approaching the *American* northern pole, which lies on the weſt ſide of the meridian, and ſeems to be of greater force than this other) the needle is drawn thereby weſtwards, ſo as to counterbalance the direction given by the *European* pole, and to make a ſmall weſtern variation in the meridian of the *Land's End* itſelf; yet about the meridian of the iſle of *Tercera*, it is ſuppoſed our neareſt pole may ſo far prevail as to give the needle a little turn to the eaſt, tho' but for a very little ſpace; the counterbalance of thoſe two poles permitting no conſiderable variation in all the eaſtern parts of the *Atlantic* ocean, nor upon the weſt coaſts of *England*, and *Ireland*, *France*, *Spain* and *Barbary*: But to the weſtward of the *Azores*, the power of the *American* pole overcoming that of the *European*, the needle has chiefly reſpect thereto; and turns ſtill more and more towards it, as you approach it; whence it comes to paſs that on the coaſt of *Virginia*, *New-England*, *New-foundland*, and in *Hudſon*'s ſtreights the variation is weſtward; that it decreaſes as you go from thence towards *Europe*; and that it is leſs in *Virginia* and *New England* than in *New-foundland* and *Hudſon*'s ſtreights: This weſterly variation again decreaſes, as you paſs over north *America*, and about the meridian of the middle of *California*, the needle again points due north; and from thence weſtwards to *Jeſſo* and *Japan*, the variation is ſuppoſed to be eaſterly; and half ſea over, not leſs than 15 deg. This eaſterly variation extends over *Japan*, *Jeſſo*, *Tartary* and part of *China*, till the variation becomes weſterly, which is governed by the *European* north-pole, and which was ſaid to be greateſt in ſome part of *Ruſſia*: Towards the ſouth pole the effect is much the ſame, only that here the ſouth point of the needle is attracted; hence it will follow that the variation on the coaſt of *Braſil*, at the river *Plata*, and ſo on to the ſtreights of *Magellan* ſhould be eaſterly, if we ſuppoſe a magnetical pole ſituated about 20 deg. more weſterly than the ſtreights of *Magellan*; and this eaſterly variation doth extend eaſtwards over the greateſt part of the *Ethiopic* ſea, till it be counterpoiſed by the virtue of the other ſouthern pole; as it is about mid-way between the *Cape of Good Hope* and the iſles of *Triſtan d'Alcunha*: From thence eaſtwards, the *Aſian* ſouth pole becoming prevalent, and the ſouth point of the needle being attracted thereby, there ariſes a weſtern variation very great in quantity and extent, becauſe of the great diſtance of this magnetical pole from the pole of the world; hence it is, that in all the *Indian* ſeas as far as *New Holland*, and farther, there is conſtantly weſt variation; and that under the equator itſelf, it ariſes to no leſs than 18 deg. where it is moſt; about the meridian of the iſland of *Celebes*, being likewiſe that of this pole, this weſterly variation ceaſes, and an eaſterly begins, which reaches to the middle of the *South-Sea* between *New-Zealand* and *Chili*, leaving room for a ſmall weſt variation, governed by the *American* ſouth pole: From the whole it appears that the direction of the needle, in the temperate and frigid zones, depends chiefly upon the counterpoiſe of the forces of two magnetical poles of the ſame nature; as alſo, why under the ſame meridian, the variation ſhould be in one place 29 deg. and a half weſt, and in another 20 and a half eaſt: In the *Torrid Zone*, and particularly under the equinoctial, reſpect muſt be had to all the four poles, and their poſitions be well conſidered; otherwiſe it will not be eaſy to determine what the variations will be; the neareſt pole being always the ſtrongeſt; yet not ſo, as not to be counterbalanced ſometimes by the united forces of two more remote; thus, in ſailing from St. *Helena* by the iſle of *Aſcenſion* to the equator on a N. W. courſe, the variation is very little eaſterly, and in that whole tract inalterable; becauſe the ſouth *American* pole, which is conſiderably the neareſt in the aforeſaid places, requiring a great eaſterly variation is counterpoiſed by the contrary attraction of the north *American*, and the *Aſian* ſouth pole; each whereof, ſingly, are in thoſe parts weaker than the *American* ſouth pole; and upon the north-weſt courſe, the diſtance from this latter is very little varied; and as you recede from the *Aſian* ſouth pole, the balance is ſtill preſerved by the acceſs towards the north *American* pole: In this caſe, no notice is taken of the *European* north pole; its meridian being little removed from thoſe of theſe places, and of itſelf requiring the ſame variations we here find: After the ſame manner may the variations in other places under and near the equator be accounted for.

A Roman Wall *and Multangular* Tower *at* York; *by Dr.* M. Liſter. Phil. Tranſ. N° 149. p. 238.

DR. *Liſter*, carefully viewing the antiquities of *York*, the reſidence of at leaſt two of the *Roman* emperors, *Severus* and *Conſtantine*, found a part of a wall ſtill ſtanding, which is undoubtedly of that time; it is the ſouth wall of the mint-yard, being formerly an hoſpital of St. *Laurence*, looking towards the river; it conſiſts of a multangular tower, which led to *Bootham-Bar*, and a wall, which ran the length of *Coning-ſtreet*, as may be eaſily diſcerned upon viewing it attentively on both ſides: The outſide towards the river is faced with a very ſmall ſquare ſtone, of about four inches thick, and laid in levels like our modern brick-work, but the length of the ſtones is not obſerved, being ſuch as they fell out in hewing; from the foundation twenty courſes of this ſmall ſquared ſtone are laid, and over them five courſes of *Roman* brick; ſome of theſe bricks are laid length-wiſe, and ſome end-wiſe in the wall, and were called *Lateres Diatoni*; after theſe five courſes of brick, other twenty two courſes of ſmall ſquare ſtone are laid, and then five more courſes of the ſame *Roman* bricks are overlaid, beyond which the wall is imperfect, and cop'd with modern building: Note, that in all this height there is no caſement or loop-hole, but one entire and uniform wall, from which it may be conjectured that the wall was built ſome courſes higher in the ſame order: The bricks were to be as *Thoroughs*, or, as it were, ſo many new foundations to the ſuperſtructure, and firmly to bind the two ſides together; for the wall itſelf is only faced with ſmall ſquare ſtone, and the middle thereof filled with mortar and pebble: *Vitruvius* commends brick-building before ſtone even for duration; and he gives a reaſon why the *Romans* ſuffered no brick-buildings within the city of *Rome*, as a thing not of choice but neceſſity; the law, ſays he, ſuffers not a wall to be made towards the ſtreet, ſo *Communi Loco* may be tranſlated, above a foot and a half thick, and partition walls the ſame, leſt they ſhould take up too much room; now brick-walls of a foot and a half thick, unleſs they were *Diplinthii* or *Triplinthii*, that is, either of two or three bricks thickneſs, cannot ſupport above one ſtory; but in ſo vaſt and majeſtic a city as old *Rome*, there ought to be innumerable habitations; therefore when a plain area, or building of one ſtory, could not receive ſo great a number to dwell in the city, the houſes of neceſſity were raiſed higher, and they had ſtrange contrivances of out-jetting and over-hanging ſtories and balconies, &c. which reaſons, if rightly conſidered, are great miſtakes, for at this day it is demonſtrated that a firm building may be raiſed to the height of ſeveral ſtories upon a foot and a half thick wall; the overſight of the *Romans* was owing to the vaſt bigneſs of their bricks, for the ſmaller the bricks the firmer the work; there being much greater firmneſs in ſuch a number of angles, as muſt be produced by a ſmall brick, than in a right line; and this is the reaſon of the ſtrength of buttraſſes and multangular towers, &c.

Thoſe bricks are about 17 inches of our meaſure in length, and about 11 inches broad, and two and a half thick, in round numbers; and they agree very well with the notion of the *Roman* foot, which the learned antiquary *Greaves* hath left us; *viz.* of its being about half an inch leſs than ours: They ſeem to have ſhrunk in the baking more in breadth than in length, which is but reaſonable, becauſe of their eaſier yielding that way; and ſo for the ſame reaſon, more in thickneſs, if we ſuppoſe them to have been deſigned in the mould for three *Roman* inches: This demonſtrates *Pliny*'s meaſure to be true, where he ſays; there are three ſorts of bricks; the *Didoron* which we uſe, is a foot and a half long, and a foot broad; and the meaſures of *Vitruvius*, as they are now extant, to be wrong; the copy of *Vitruvius*, where it deſcribes the meaſures of the *Didoron*, being vicious; and Dr. *Liſter* affirms, that all he had ſeen with us in *England* were of *Pliny*'s meaſures; as in the *Roman* wall at *Leiceſter*, called the *Jews* wall; and at St. *Albans*, as well as at *York*; and to go no farther for arguments than *Vitruvius*, the *Diplinthii Parietes* or walls two bricks thick, in *Rome* were againſt law, and the ſingle brick-wall was only allowed as ſtandard, *viz.* a foot and a half thick wall, or one *Roman* brick a length: *Pliny* being a profeſſed tranſcriber of *Vitruvius* in the whole bigneſs of bricks, and not differing in any one thing in the whole chapter, but in the meaſure of the *Didoron*; and the bricks themſelves demonſtrating the truth of that difference, it is but reaſonable we ſhould make *Vitruvius*'s *Longum Pede*, *Latum ſemipede*, a foot long, and half a foot broad, a fault of *Vitruvius*'s copiers: To conclude with this remark, a proportion and a plain uniformity, even in the minuteſt part of building, are obſerved, as appears from theſe poor remains of *Roman* workmanſhip; whereas in our *Gothic* buildings, there is a total neglect of the meaſure and proportion of the courſes, as if theſe were not very material to the beauty of the whole; whereas indeed in the works of nature, it is from the ſymmetry of the very grain, that much of the beauty ariſes.

Of the Colour and Diſtribution of the Chyle; *by Dr.* M. Liſter. Phil. Tranſ. N° 149. p. 242.

IT ſeems probable, 1. That in the digeſtion of meat in the ſtomach, there is made a ſeparation or ſolution of urinous ſalts, no otherwiſe than in the rotting of plants and animals. 2. That the chyle is highly impregnated with this urinous ſalt. 3. That the whiteneſs of the chyle is from the fermentation it has from its mixture with urinous ſalts, as that if diluted with fair water, it is wholly deprived of that colour, the fermentation ceaſing. 4. That the ſalt chyle is conveyed into the venal blood, and with it enters the heart, and is thence thrown out chyle again, as it comes in, by a continual pulſation into the arteries. 5. That as often as it enters the emulgent arteries, it there leaves behind it part of its ſaline liquor, or urine, and conſequently loſes of its colour. 6. That when ſufficiently freed of its urinous ſalt, it becomes a *Lympha*, which is taken for nothing other but the reſidue of the chyle, not yet changed into the nature of blood, as not ſufficiently depurated of its ſaline particles. 7. That probably it circulates for a long time under the nature of a *Lympha*, often viſiting all the parts of the body by the arteries, and returning again to the heart, partly by its own veſſels, and partly by the veins. 8. That in defect of chyle, for we cannot conſtantly feed, nature continually ſupplies the maſs of blood with the *Lympha*, or old chyle. 9. That upon every ſupply of freſh chyle, much of the old ſtock or *Lympha* is, according to the exigency of the parts, converted to this or the other uſe, and not till then. 10. That there is always more *Lympha* in the maſs of blood than is neceſſary for diluting it; the arterial blood, be the animal never ſo much exhauſted by hunger, always ſeparating ſome upon extravaſation or coagulation. 11. In the coagulation of extravaſated blood, there is no precipitation of parts, as in curdled milk, *&c.* for if the chyle be freſhly diſtributed into the maſs of blood, it will again ſeparate itſelf as oil from water, and juſt ſo it is with the *Lympha* or old chyle, neither of them being as yet any eſſential part of the blood. 12. The venal and arterial blood have both of them probably a like quantity of *Lympha* to dilute them; but the arterial in coagulating, involves within its *Craſſamentum* more than the venal; and the reaſon may be, that the arterial is fuller of air, which rarifies and renders its *Craſſamentum* more porous and capable of lodging the *Lympha*; which, as it ſubſides by long ſtanding, ſeparates more and more *Lympha* daily. 13. The great inſtrument of the circulation of the blood, is a ſyſtole or vibration of the heart, which yet would not be ſufficient for hindring the coagulation of the blood, without a continual ſupply of the *Lympha* to dilute it.

A Fœtus *formed in the* Ovarium; *by.* M. de St. Maurice. Phil. Tranſ. N° 150. p. 285.

M*Adame de Sainte Mere* had been ſafely brought to bed eight times; and after having continued five years without being with child, about three months before her death, ſhe ſuſpected herſelf in that condition again: But *April* 22d, 1682, after being up in the morning in very good health, ſhe fell into fainting fits, whereby from that moment ſhe abſolutely loſt her pulſe, without being deprived either of her underſtanding or ſpeech; in the evening her countenance was deadiſh, and covered with a clammy cold ſweat; ſhe complained of a great colick in the region of the right groin, which terminated at the reins; this colick was ſo violent, that ſhe could not bear to touch the part; in a moment after ſhe felt all the preludes of an imminent labour; ſhe called for her ſurgeon, and died in his arms.

Upon opening the integuments of the belly, all the intrails in the epigaſtric region were ſeen floating in blood; there was a prodigious quantity of coagulated blood in the right flank, and attempting to take it out with the hand, there was found amongſt the firſt clots, which were drawn forth, a little *Fœtus*, about the bigneſs of a thumb, and a third leſs in length, all very diſtinctly formed, and in which was manifeſtly diſcovered the ſex of a boy, but naked and without covering; two fingers from this place the right *Cornu* of the womb was found; the teſticle was torn lengthwiſe, and thro' the middle on the ſide; it did not touch the *Tuba*, and all its cavity was full of clotted blood; and it was no longer a doubt, but this was the place, where this infant was formed; but having acquired in this place a growth too large to be able to fall in time, and continuing to grow there, without being able to come forth, it had at length broken its priſon by ſtretching it: And this opinion was confirmed from comparing this teſticle with the left, being at leaſt four times bigger, its bulk approaching that of a hen's egg, while the left was not larger than a ſmall cheſnut; it was all red both without and within, beſides the clotted blood that it contained; whereas the left was pale and full of ſmall grains of the colour and conſiſtence of yellow tallow: Upon examining the tube on the right ſide, it could not be found that this infant had ever entred there; and it was in all reſpects like the left tube: Laſtly, upon examining the body of the womb with all the care and exactneſs poſſible, it appeared without any rent, and in a ſtate purely natural; only it was obſerved to be a little bigger than it is found in women who die without being with child; it was all as Dr. *Harvey* deſcribed it in the firſt month of pregnancy; but when it was opened, there was not the leaſt ſign of conception; it is true, the veſſels of the interior membrane appeared full of blood, and varicoſe.

A Parallel betwixt Lightning *and* Phoſphorus; *by Dr.* Fred. Slare. Phil. Tranſ. N° 150. p. 289.

IN order to keep the ſolid phoſphorus from conſuming, it was uſually placed at the bottom of a glaſs of water; Dr. *Slare*, having ſeveral of theſe glaſſes diſpoſed upon a table in view, could obſerve ſeveral flaſhes of light, that ſucceſſively paſſed thro' the water, and made ſuch bright and vigorous coruſcations in the air, as would ſurpriſe and affrighten one not accuſtomed to the phænomenon; this fiery meteor paſſes a little contracted thro' the incumbent water, but expands itſelf much, as ſoon as it emerges or gets above it: If you would make theſe experiments to advantage, the glaſs ſhould be deep and cylindrical, and not above three quarters filled with water: If we compare theſe appearances with lightning, we may obſerve that the latter, which comes at intervals, paſſes uninterrupted thro' the moſt condenſed clouds, and is not extinguiſhed or obſtructed by the greateſt ſtorms or cataracts of water, but, like the beams of the ſun, or any other fire, freely paſſes thro' glaſs and water.

This phoſphorus in the above-mentioned ſtate only emits theſe flaſhes of light in warm weather; a certain temper of the air being neceſſary to produce the effect; for in winter, or cold weather, he never obſerved it; and thus warm ſummer weather is moſt productive of lightning.

The above-mentioned flaſh of light is not apt to kindle or burn any combuſtible matter, as he found by holding his finger in it, as alſo holding in its flame, paper, flax, and ſuch materials as are apt to take fire; and ſuch an inoffenſive flame that of lightning is generally obſerved to be: But again, the matter of the phoſphorus, whilſt in a more condenſed body, will be eaſily kindled by the warmth of the air, or by the immediate beams of the ſun, and then it will burn very furiouſly, and with ſuch a penetrating fire, as will not eaſily be extinguiſhed; and thus lightning, when condenſed or contracted, and wrapt up in a vehicle of air, as not ſo eaſily to diffuſe itſelf thro' the yielding *Æther*, will then ſet fire to houſes, trees, *&c.* and do great miſchief.

The phoſphorus, whilſt burning, acts the part of a corroſive, and when it goes out, it reſolves into a menſtruum, that diſſolves gold, iron, and other metals; thus lightning produces the ſame effect.

Upon taking between ten and twenty grains of the ſolid phoſphorus, and melting it in as much water as would juſt cover it, which was about a drachm; after it was actually cold, it was poured into two ounces of oil of vitriol; which, being well ſhaked together, did firſt heat, and then throw up fiery balls, which, like ſo many ſtars, adhered to the ſides of the glaſs, and continued to burn for ſome time: Upon the addition of a ſmall quantity of oil of turpentine to the preceeding mixture, without ſhaking the veſſel, it took fire, and burned very furiouſly; it alſo ſucceeded with *Petroleum*, and oil of bricks; but ſalad-oil and ſpirit of wine could not be made to flame.

An Earthquake *at* Oxford; *by Mr.* Tho. Pigot. Phil. Tranſ. N° 151. p. 311.

SEPT. 17th, 1683, an earthquake happened here at *Oxford*, at a time when ſuch effects are commonly experienced, if we may credit *Ariſtotle*, who tells us, that they are moſt frequently in ſpring and autumn; in which there is a greater abundance of vapours, and a larger quantity of nitre exhaled; all which ingredients may conſpire to the production of an earthquake; for, if we conſider how capable they are of a large expanſion, how forcible they are when rarified in cloſe veſſels over the fire, we may ſuppoſe that thoſe vapours, which produce ſo great commotions in the air, may cauſe a conſiderable diſturbance in the earth, when pent and locked up therein: The latter part of the firſt week in *September* was ſo rainy, that many were apprehenſive of a deluge; the 9th of *September* there fell ſome very conſiderable ſhowers in the afternoon; but from that time it cleared up, and to the end of the enſuing week, it continued very warm and pleaſant weather; the 16th, in the evening, was inclinable to froſt; and the next morning it was a very hard froſt for the ſeaſon; and then about 7 o'clock, the day being very clear and calm, the earthquake happened; Dr. *Wallis* and Mr. *Boyle* made the like obſervations of cold preceeding the earthquake of 166⅚: The quickſilver in the barometer ſtood as high then, as at any time for three years before, which, together with a remarkable calmneſs of the air, a matter generally looked upon, as one of the circumſtances which accompany earthquakes, and by many reckoned amongſt the ſigns which preceed them, may be ſufficient to ſhew how free the air was from vapours at that time; and ſurely, the fewer there were above, the more may be ſuppoſed below: *Ignes fatui* were frequently ſeen a few days before this earthquake, which may at leaſt be a probable argument to ſhew how full the earth then was of damps and exhalations; ſince a ſtench, that tainted well-water in an unuſual manner, hath upon the ſame account been generally reckoned amongſt the ſigns of an earthquake, and by which it may be predicted; for by this it was, that *Pherecydes* is ſaid to have preſaged the earthquake at *Lacedemon*; and *Helmont* mentions another, who pre-

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pretended to the ſame fore-ſight, by taſting the water of a very deep well in the caſtle of *Louvain*: The motion of this earthquake was not of that ſort, which are termed pulſes or ſuccuſſions, ſuch as ſtrike the ground at right angles with a violent ſhock, or intermittent knocking, ſo as often to raiſe the earth to a conſiderable height, or force their way by a breach; but it appeared rather to be ſuch a trembling motion, as vibrates and ſhakes without altering the poſition of the earth, and leaves all things in the ſame poſture in which it found them; for it ſhook the earth with a tremulous and vibratory motion, whoſe reciprocations were repeated with a great deal of quickneſs; the pulſes were a little diſcontinued, and yet they came ſo thick that there was no reckoning of them, tho' the whole earthquake continued here ſcarce more than ſix ſeconds of time; and when it ended, the motion of reſtitution, or ſettling of the building, in which this obſerver was, ſeemed to be with a craſh: Now as tremulous and vibratory motions are proper to produce ſounds, ſo was this earthquake accompanied with a hollow murmuring, like a diſtant thunder; which ſound kept time ſo exactly with the motion, and was ſo conformable to it in all reſpects, that it plainly appears there was the ſame reaſon for both; to thoſe that were within doors it appeared to be more conſiderable, and as it were above in the air, occaſioned chiefly by the ſhaking of the building; but thoſe, who were abroad in the fields and open air, perceived a hollow murmur with a gentle ſhaking towards the ſurface of the earth, not unfitly compared to the groaning of ſome planks of elm, aſh, or fir, when the application of fire cauſes both a trembling and a ſound: That there is a conſiderable heat within the earth, is manifeſt from the experience of miners working in the deeper grooves; from thoſe hot ſprings which burſt out thence, and from fermentations cauſed by mineral ſpirits: Nor is it leſs commonly obſerved, that ſuch heats and fermentations within the earth are augmented by froſty weather; when the ſteams being more pent up, do work more forcibly upon each other: And that ſounds and tremors may be produced by ſuch heat, tho' it work only on air, watry vapours, or nitre included in pores and cavities, appears from ſeveral experiments; as that of filling glaſs-bubbles half full with water and nitre; which brought to the heat of the fire will tremble with a ſort of humming ſound, and after that break with a great deal of noiſe and violence.

The extent of this earthquake was but 70 miles, or thereabouts; its largeſt diſtance was from ſouth-eaſt to north-weſt, the leaſt from north to ſouth; which is a very inconſiderable ſpace, if compared with that which happened in the ſouthern parts of *Norway*, *April* 24th, 1657, and took up 160 miles in length, and as many in breadth; and *Kircher* mentions one 200 miles in length.

There was another earthquake far more conſiderable, which happened *October* 9th, about 11 o'clock at night in *Oxfordſhire*, northwards it was perceived much; it ſpread all over the *Mid-land* counties, and extended into *Derbyſhire*; in which, as in the coal-countries, it was very violent.

Hiſtorical Obſervations *relating to* Conſtantinople; *by Dr.* Tho. Smith. Phil. Tranſ. N° 152. p. 335.

Conſtantinople, formerly *Byzantium*, was ſo called by *Conſtantine the Great*, after his own name; who being extreamly delighted with the beautiful and advantageous ſituation of the place between two ſeas, and defended by narrow ſtreights on both ſides, removed the ſeat of the empire thither, and laid the foundation of its future ſplendour and greatneſs: It was alſo called the ſecond or new *Rome*, in emulation of old *Rome*, which it was deſigned this ſhould equal, by a ſpecial edict, or law of the ſame emperor, which he cauſed to be engraven on a marble pillar, placed near his own *Equeſtrian* ſtatue, in one of the piazza's of his new built city, called *Strategium*, where the ſoldiers uſed to muſter, as in the *Campus Martius*: Accordingly he endowed it with the ſame privileges and immunities, and eſtabliſhed the ſame number of magiſtrates and orders of people, and divided the whole extent of it into 14 precincts or regions, according to the diviſion of old *Rome*; and the *Greek* writers were as extravagant in their commendations of it; but the uſual title in their ordinary diſcourſes and writings, when they mentioned it without any flouriſh, was, ἡ Βασιλευȣσα, or ἡ Βασιλις, that is the imperial city: The country about it was afterwards called *Romania* in a limited and reſtrained ſenſe, (for that *Romania*, about the middle times of the empire, when it began to decline, was the ſame with *Orbis Romanus*, ſeems clear from *Epiphanius*) and the people Ρωμᾶιοι, and the *Greeks* ſtill retain the name; for if you aſk any of them born upon the continent of *Thrace*, what countryman he is, he anſwers forthwith, Ῥωμαῖος. *Romios*, for ſo they pronounce it; the *Turks* in like manner call a *Greek* chriſtian, *Urum Gaour*, or the *Roman* infidel; and they will ſometimes call the emperor of *Germany*, *Urumler Padiſha*, or the emperor of the *Romans*; hence it was, that the later *Greek* emperors ſtiled themſelves Βασιλεῖς ῾Ρωμαιων, kings of the *Romans*; that is, ſuch as were born in *Romania*, and the other countries, which made up the eaſtern diviſion of the *Roman* empire; tho' perchance by this florid title they pretended a right to the government of the weſt; upon which vain preſumption, they aſſumed alſo the title of Κοσμοκρατορες, or emperors of the world, as if they had been the true ſucceſſors of *Auguſtus*, and as if the weſtern emperors had been uſurpers, whom they called by way of contempt, Ρηγες, *Reges*; as *Luitprandus* informs us in the account of his embaſſy to *Nicephorus Phocas*; and they gave the people of *Italy* no other name than that of *Longobards*, or *Lombards*: The modern *Greeks* call all the weſtern chriſtians, Λατινοι or φραγγοι, *Latins* or *Franks*; the *Turks* only making uſe of the latter, when they ſpeak civilly of us, and calling *Chriſtendom*, *Phrenkiſtan*, in the modern *Greek*, φραγγια: And the *Turks* do now as proudly call *Conſtantinople*, *Alem Pena*, or the refuge of the world; where indeed there ſeem to be a medley of all or moſt nations of three parts of it, and of all religions, which are tolerated, and publickly profeſſed and exerciſed every where throughout the empire, except the *Perſian*; for they look upon the latter as a corruption of, and deviation from the rules and doctrine of *Mahomet* their prophet; and therefore they abſolutely forbid it, as repugnant to, and deſtructive of the doctrine of life and ſalvation, as they ſpeak; and accordingly they condemn with all imaginable fury the profeſſors thereof, who pretend to follow *Ali*, as *Sectaries* and *Apoſtates*, and entertain a worſe opinion of them than of *Chriſtians*, *Jews*, or *Infidels*: The *Perſians* are not behind hand with them in their hatred and contempt, deriding them as groſs and ſtupid, and looking upon them as little leſs than barbarians; intereſt and zeal for their ſeveral tenets highten their differences ſo much, that in time of war they deſtroy each others moſques.

The *Greeks* have 26 churches within the walls of the city, beſides ſix at *Galata*; they have alſo two churches at *Scutari*, one at *Kadikui* or *Calcedon*, as alſo at *Stauroſis*, *Chingilkui*, and ſeveral other villages upon the *Aſian* ſhore of the *Boſphorus*, as at *Beſhictaſh*, *Ortakui*, *Chorouch Cheſme*, which latter is dedicated to St. *Michael* the archangel; at *Jenikui*, or *Neochorion*, *Therapia*, *Bujukdere*, and other villages on the *European* ſide; they have alſo a church at *Haskui*, where their burying place is, and another near the *Bagno*, dedicated to St. *Paraſceve*; and at *Tatoula*, about a mile from *Pera*, upon a hill, which from the name of the church is by the *Greeks* and *Franks* called St. *Demetrius*'s hill; next to the *Holy Virgin*, St. *Demetrius*, and St. *George* have moſt churches dedicated to them: The *Armenians* have not above ſeven churches, being few in number in compariſon of the *Greeks*: The *Jews* have in the city and places adjacent between twenty and thirty ſynagogues; this city next to *Cairo* and *Saloniki* affording the greateſt ſhelter to that unhappy and contemptible people of any other, in the Grand *Seignior*'s dominions, and there may be about 20 or 30,000 families of them; they are of great ſervice to the *Turks*, on account of their brokage, merchandizing, and induſtry in ſeveral mechanical trades; and all theſe may be looked upon as natives, or rather ſlaves, each paying money yearly for his head; it is true, theſe *Jews* very wiſely collect this tax amongſt themſelves; and according to an agreement made with the *Tefterdar*, or treaſurer, they pay a certain ſum in groſs for their whole nation reſiding there; by which piece of cunning they are great gainers, and ſpare the poor amongſt them, leſs able to pay, by a contribution of the rich to make up the ſum: The *Engliſh* and *Dutch* ambaſſadors have their chapels in the palaces common to their reſpective nations: The churches and chapels of the weſtern chriſtians of the *Roman* communion at *Galata*, are St. *Peter*'s, belonging to the *Dominicans*, where is the famous piece of *Madonna di Conſtantinopoli*, as the *Italians* call it, or of the bleſſed Virgin, holding the holy child *Jeſus* in her arms; which they pretend was drawn by St. *Luke*, celebrated by ſome of the later eccleſiaſtical writers as a famous painter; out of regard to this idle tradition, the credulous and ſuperſtitious *Latins* and *Greeks* of the *Roman* communion ſhew great veneration to it, which otherwiſe hath little in it of proportion, art, or beauty, to derive any reputation either upon the deſigner, or his work: St. *Francis*'s, belonging to the conventual friars of the order of St. *Francis*; the ground of this church was, by the wiſe conduct and interceſſion of *Cavalliere Molino*, the *Venetian Bailo*, after the ſurrender of *Candia*, upon the peace made by the republic with the Grand Seignior, procured to be reſtored, and a handſome church rebuilt with the large contributions of money ſent out of *Chriſtendom*: St. *Benedict*'s, belonging to the *Jeſuites*, where is a rich altar curiouſly adorned with ſeveral figures in moſaic; this convent was purchaſed for them by their great benefactor, *Henry* IV. of *France*: St. *Mary*'s, belonging to the *Obſervantines*, or *Zoccolanti*, a branch of the order of St. *Francis*, ſo called from their going in *Zoccoli*, or wooden clogs: The Capuchins have a little chapel dedicated to St. *George*, near the *French* ambaſſador's palace: St. *Ann* is a chapel frequented by the *Perots*: St. *Paul*'s and St. *Anthony*'s were both taken away, ſome years ſince, from the chriſtians, and converted into moſques; the former of which is now known by the name of *Arab Giameſi*, or the moſque of the *Arabians*; and the *Turks* had alſo ſeized on the church of St. *John*; the *Jews* were poſſeſſed of St. *George*'s and St. *Sebaſtian*'s, which was wont to be viſited chiefly on holy-days.

The wind which blows for the moſt part at *Conſtantinople* is the northerly, which muſt be aſcribed to its nearneſs to the *Euxine* ſea; ſo that for want of ſoutherly winds, ſhips have been forced to lie a month, or ſometimes two, near the mouth of the *Helleſpont*; this was obſerved long ago by *Eunapius* in his life of *Ædeſius*, who aſcribes the infrequency of the ſouth wind to the ſituation of the mountains; whereas it is checked and overpowered by the exuberance of the vapours continually ſent forth from the black and great ſea, as the *Greeks* call it in compariſon of the *Mediterranean*.

The *Helleſpont* is about 40 miles in length; and at the caſtles of *Seſtos* and *Abydos*, the ſtreight is about three quarters of an *Engliſh* mile over, or leſs: The length of the *Propontis* is about 150 miles; both ſhores may be ſeen in the middle of it; in it are *Cyzicus*, an iſland near the *Aſian* ſhore, to which it is joined by two bridges; and ſtill retains its ancient name, and is the ſeat of a biſhop, being inhabited by a conſiderable number of *Greeks*: *Proconneſus*, not far from the former, now called *Marmora*, as it has been for ſome centuries, from the excellent quarries of marble found there; the *Marmor Cyzenicum* was alſo famous in *Pliny*'s days: *Besbycus*, now called by the *Greeks* Καλολιμνο, or the *Good* haven, is at no great diſtance from the entrance into the bay of *Montanea*, to the N. by E. The *Turks* call it *Imramle*: There are ſeveral iſlands over againſt the bay of *Nicomedia*, formerly called *Sinus Aſtacenus*, according to *Strabo*, about ſix or ſeven leagues from *Conſtantinople*; as, *Prote*, ſo called becauſe they approach firſt to it, upon coming from *Conſtantinople*; to the ſouth of this are *Prencipe* and *Pytis*, which Dr. *Smith* takes to be the ſame with *Pyrgos*, and which lies inmoſt towards the bay; *Chalcitis*, in modern *Greek*, *Chalce* or *Chalcis*; and *Oxia* and *Platy* to the north weſt.

The *Seraglio* is at the extreme point of the north-eaſt angle of *Conſtantinople*, where formerly old *Byzantium* ſtood; within which, towards the haven, is a ſtately *Kiosk*, or ſummer-houſe, from which the grand ſeignior uſually takes barge, when he paſſes into *Aſia*, or diverts himſelf upon the *Boſphorus*; at which time the *Boſtangi Baſha*, who hath the principal care of the emperor's palace, and the command of the *Boſphorus*, ſits at the helm and ſteers: The ſeven towers are at the ſouth-eaſt extremity: The only ſuburbs are to the north-weſt, along the ſide of the haven; for above the hill, where the three walls begin, there lies an open champaign country, only here and there, at conſiderable diſtances, are farm-houſes: The haven runs in from the weſt, and ſo opens eaſtward: At the eaſt end of *Galata* is *Tophana*, where they caſt their great guns: *Pera* and *Galata* have about ſix gates towards the ſea: The whole tract of ground was anciently, before the emperor *Valentinian*'s days, who encloſed and fortified *Galata* with walls and towers, ſtiled Περαια, or *Regio Peræa*, becauſe it lay on the other ſide of the city to the north, ſeated on higher hills, and whoſe deſcent is more ſteep and difficult.

Our modern geographers, as *Mercator* and *Ortelius*, who herein follow *Ptolemy*, place *Conſtantinople* in the latitude of 43 deg. and five minutes; the *Arabian* and *Perſian* aſtronomers, as *Abulfeda*, *Naſſir*, *Eddin*, *Ulugh Beigh*, and the προχειροι Κανονες of *Chryſococcas* tranſlated from the *Perſian* tables place it more northerly, *viz.* in 45 deg. which by later and better obſervations is found to be falſe; Mr. *Greaves* took the height of the pole at *Conſtantinople* with a braſs ſextant of above five foot radius, and found it but 41 deg. 6 m. but Dr. *Smith*, by a very good quadrant, found it only 40 deg. 58 min. There is no ſpace between the *Propontis* and the walls of the city, except juſt at the ſeraglio point, which may be two hundred paces in length; where they have raiſed on a platform a battery for great guns; but from the point to the end of the haven weſtward, the ſpace to the gates is unequal; in ſome places about 20 paces broad, in others three or four times that number: The diſtance between *Conſtantinople* and *Chalcedon* upon the oppoſite *Bithynian* ſhore, may be about three or four miles: On the walls are engraven the names of ſeveral emperors, who reigned about the declenſion of the

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Grecian empire: as *Theophilus*, *Michael*, *Baſilius*, *Conſtantinus Porphyrogenitus*, by whoſe care, and at whoſe expence, the ſeveral breaches, cauſed in them by the ſea or earthquakes, were repaired: *Kumkapi*, or the ſand-gate, lies towards the *Propontis*; this the *Greeks* call in their vulgar language Κονδοσκαλι, *Contoſcalium*, or the little ſcale or landing-place; here formerly was an arſenal for gallies, and other ſmall veſſels: *Jedicula Kapi*, or the gate of the ſeven towers, ſo called from its nearneſs to that *Acropolis*, which Dr. *Smith* conjectures the *Greeks* formerly called Χρυση, or the golden gate, and by ſome *Latin* writers *Chryſea*, in *Luitprandus*, *Carea*, which muſt be certainly a miſtake either of the tranſcriber or printer for *Aurea*; this gate is in the twelfth region, and was alſo called 'ωραια, from its beautiful and curious ſtructure: The *Gun-gate*, was formerly called *Roman-gate*; not becauſe it leads towards the continent of *Romania*, or *Thrace*, but from St. *Romanus*, where the laſt chriſtian emperor was killed at the aſſault, which the *Turks* made to force their way by it into the city: Near *Adrianople-gate* is a fair large moſque, called *Ali-baſſa*, on a hill accounted the higheſt in the city: The diſtance between one tower and the other in the upper wall towards the land is about 90 paces; the ſpace between that and the ſecond wall is about 18 paces over: The place, where the lions, leopards and other wild beaſts are kept, as ſeveral jackals, was formerly a chriſtian church dedicated to Παναγια, or the bleſſed virgin.

There is no tide, or running back of the water on any ſide of the *Boſphorus* into the *Black Sea*, as ſome have imagined; whoſe miſtake might poſſibly ariſe hence, that the wind being at north, and blowing hard, the current ſets more violently at ſuch times againſt the ſeveral head-lands, jutting out into the channel, which admits of ſeveral turnings, and ſo the waters are forced back to ſome little diſtance; or elſe, becauſe when the ſouth wind freſhens and grows boiſterous, it makes a high rolling ſea in the *Propontis* and *Boſphorus*, and being contrary to the current, gives a check to it, ſo that it becomes leſs ſenſible, and is eaſily ſtemmed: Where it is narroweſt, the diſtance ſeems to the eye to be ſcarce from one ſhore to the other a mile over; and where broadeſt not much above a mile and a half, unleſs where it runs into the deep bays, which on account of their ſhallowneſs, only harbour boats: The channel is certainly natural, and not cut out by art, as ſome have idly fancied, not conſidering how the *Euxine* ſea ſhould otherwiſe

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diſcharge itſelf of thoſe great quantities of water, poured into it by the *Iſter* or *Danube*, and the *Tanais*, now called the *Don*, and the other rivers, whereby it becomes leſs ſalt, even very ſenſibly to the taſte, than ſeveral parts of the *Mediterranean*.

Fiſhes, by a ſtrange kind of inſtinct, paſs in vaſt ſhoals twice a year, *viz*. autumn and ſpring, thro' the *Boſphorus*; of which the *Greeks* take great numbers, and ſupply the markets at eaſy rates; cormorants, and other ravenous water-fowl, which the *Turks* will not ſuffer to be deſtroyed, or otherwiſe moleſted, prey alſo upon them.

The weather in ſome months is very inconſtant, great heats and colds happening the ſame day upon the change of wind; the winters at *Conſtantinople* are ſometimes extraordinary ſevere; and Dr. *Smith* was told by ſeveral old *Greeks*, that the *Boſphorus* was frozen over in the time of *Achmed*, and that a hare was courſed upon it; it happened thus, upon a thaw, huge flakes of ice came floating down the *Danube* into the *Black Sea*, which were driven by the current into the *Boſphorus*, where, upon the return of the froſt, they were fixed ſo hard, that it became paſſable; in 1669 there was ice in the haven to the great amazement of the *Turks*, and ſome were ſo affrighted at this unuſual accident, that they looked upon it as a diſmal prodigy, and concluded that the world would be at an end that year.

The *Aguglia*, or obeliſk in the *Hippodrome*, is between 50 and 60 foot high; the hiſtorical pillar in *Baſſo Relievo*, erected in honour of the emperors *Arcadius* and *Honorius*, is about 147 foot high: *Alexius Comnenus* lies buried in the patriarchal church againſt the wall, together with his daughter *Anna Comnena* the hiſtorian, who lived about the year of *Chriſt* 1117: They pretend to ſhew there the reliques of St. *Anaſtaſia*, who ſuffered martyrdom under the emperor *Valerianus*, and of St. *Euphemia*, virgin and martyr under *Diocleſian*: In *Sancta Sophia* there are pillars ſo large, that a man can ſcarce fathom them at twice; at the end of the gallery, that joins the other two, each about 30 paces wide, there is a piece of tranſparent marble two or three inches thick; in the north gallery, upon the pavement, is a reddiſh ſort of marble, brought, as the *Turks* and *Chriſtians* relate from *Paleſtine*, and on which, they ſay, the bleſſed Virgin uſed to waſh our Saviour's linnen; there is but one ſtep from the body of the church to the *Bema*, or place where the altar formerly ſtood: The great moſque at *Chaſim-baſſa* on *Pera* ſide weſtwards, was formerly a church dedi-

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dedicated to St. *Theodoſia: Giangbir*, a moſque ſo called, ſtands upon a hill at *Fondaclee* near *Tophana*.

In *Conſtantinople* there are ſeveral narrow ſtreets of trade, cloſed up with ſheds and pent-houſes; and beſides theſe places, ſeveral trades have their diſtinct quarters; the ſtreets are for the moſt part raiſed on each ſide for the greater conveniency: Not far from *Suleimania* is the houſe of the *Aga*, or General of the *Janizaries*, which ſo often changes its maſter: *Pompey*'s pillar, as the *Franks* erroneouſly call it, is of the *Corinthian* order, curiouſly wrought, and about 18 foot in height, and three in diameter: In *Beſhiktaſh*, a village within two or three miles of *Conſtantinople*, towards the *Boſphorus*, lies buried the famous pyrate *Ariadin*, whom the chriſtian writers call *Barbaroſſa*, who built here a handſome moſque with two rows of pillars at the entrance; the captain *Baſſa*, before he puts to ſea with his *Armata* or galleys, uſually viſits the tomb of this fortunate robber, who had made ſeveral thouſand Chriſtians ſlaves, and makes his prayers at the neighbouring church for the good ſucceſs of his expedition.

In the city they reckon above 100 publick baths, ſcarce any ſtreet without one; they are eſteemed works of great piety and charity, there being a continual occaſion for them, not upon account of religion, but for health and cleanlineſs; for their diet being generally hot ſpiced meats in winter, and crude fruits in ſummer; their liquor fountain-water or coffee; and leading lazy indolent lives, frequent bathing becomes neceſſary; for they never uſe walking either for digeſtion or diverſion.

There are ſeveral reſervoirs of water under ground, and one particularly under the church of *Sancta Sophia*; theſe were of great uſe to the poor *Greeks* in the laſt fatal ſiege; but the *Turks* are ſo ſecure, that they do not think them worth either coſt or pains to keep the waters ſweet, or the ciſterns in repair.

The aqueducts, which anſwer to thoſe glorious aqueducts near *Pyrgos*, and which convey the water to the great ciſtern near Sultan *Selim*'s moſque, are in that part of *Conſtantinople*, which lies between the moſques of *Mahomet* the *Great* and *Shazade*.

The *Turks* began to beſiege *Conſtantinople* on the 5th of *April*, and took it the 29th of *May*, on *Whitſun Tueſday* morning 1453; or, as the *Turks* reckon, in the year 857 of the *Hegira*, or flight of *Mahomet*, the 22d day of the firſt *Jomad*.

The chapel, where *Ejub Sultan* is interred, at whoſe head and feet there are great wax-candles, is incloſed with latten wire-grates, for the better accommodation of ſuch religious *Turks*, as come to pay their reſpect to the memory of this great muſſulman ſaint; in the middle of the area there is raiſed a building ſuſtained by excellent marble pillars, aſcended by two ſeveral pair of ſtairs, where the new emperor is inaugurated, and whether he uſually goes in *Bairam* time.

The Diſſection of a Mexican Muſk-Hog; *by Dr.* Edw. Tyſon. Phil. Tranſ. N° 153. p. 359.

THE ſhape of this animal, which by ſome authors is called *Tajacu*, is ſuch, that it may be eaſily reduced to the ſwine-kind, tho' much leſs than our common hogs; for from the end of the body, where the tail ſhould be, to the top of the head between the ears, were two foot and two inches; from thence to the extremity of the ſnout 11 inches; the compaſs of the body was two foot, that of the neck 16 inches, of the head in the largeſt place 18 inches, and of the ſnout 12 inches; for the lower jaw in this *Mexican* hog was more protuberant, and the head leſs tapering than in our ſwine, and in the ſkeleton appears much like that of a *Baby Rouſſa*, only it had not thoſe teeth; and the neck appeared ſo very ſhort and thick, not from thoſe large glands, which in ſome of the ſwine-kind do ſo ſtuff out their necks, but from the ſhort turning upwards of the *Vertebræ* of the neck, which were kept cloſe to the body, by the inſertion of that ſtrong ligament from the back into the head, which, in prone animals, is of extraordinary uſe, and adds much to the ſtrength of this animal: The colour of the body was griſly; it was beſet with briſtles, which were thicker than thoſe of a hog, and ſmaller than thoſe of a hedge-hog, but reſembling them, or the quills of a porcupine, and they were variegated with black and white rings: The belly was almoſt bare; the briſtles on the ſides were ſhorter, and gradually increaſed in length, as they approached the ridge of the back, where ſome were five inches long; on the head between the ears there was a large tuft of theſe briſtles, which were moſtly black: The ears were about 2 ½ inches long and pricking up; the eyes, as they are commonly in pigs, were but ſmall; from the lower *Canthus* or angle of the eye to the end of the ſnout were ſix inches; the ſnout was like that of a hog's; the mouth was but ſmall; one ſide of the lower lip is made ſmooth by the rubbing of the tuſk in the upper jaw: The feet and claws are perfectly like thoſe of common hogs; it had no tail; but what is moſt peculiar, and diſtinguiſhes it from any other animal, is the teat or navel, or rather *Foramen* on the hinder part of the back: Theſe animals are found in *Panama*, *New Spain*, *Nicaragua*, *Terra Firma*, and *Braſil*; they are uſually met with in the mountains and woods, and they go in herds together; they feed on roots, acorns and fruits; but as the greateſt delicacy, they hunt out all manner of poiſonous ſerpents and toads; and having caught them, they hold them with their fore-feet, and with a great deal of dexterity they ſtrip off the ſkin with their teeth from the head to the tail, and then greedily devour them; and they are ſaid to eat the root or bark of a certain tree, as an antidote againſt the poiſon; and by this means they are well fed and become big; when tame they will feed on any thing; but they are naturally very fierce: If any of them be wounded, preſently he gets to his aſſiſtance a great number of his kind, and never deſiſts till he has revenged the injury, or is ſlain; they are always at enmity with the tygers, and there is often found the body of a tyger, and many of theſe *Tajacus*'s ſlain together; if they ſpy a man they will fiercely ſet upon him, and his beſt refuge is to get up a tree, which they will moſt furiouſly aſſault with their teeth; nor will they eaſily quit him, till forced by hunger, or ſlain; if they are hunted they tear the dogs in pieces; their fleſh is eſteemed very good, and much deſired by the inhabitants, tho' they have but very little fat.

To come now to the diſſection; after dividing the muſcles of the belly, what was remarkable, was the ſtructure of its three ſtomachs; the *Oeſophagus* or gullet was inſerted into the middlemoſt, which we may therefore call the firſt ventricle or ſtomach; from this on one ſide was a large paſſage into the ſecond, which pouching out had its two ends winding like a horn, and on the other ſide of the firſt or middle ſtomach was a free open paſſage into the third, which emptied itſelf into the *Duodenum:* The firſt ſtomach was lined within, with a white thick hard membrane, almoſt like the inward pellicle of the gizzard of fowls, and this none of the other ſtomachs had; for the inward ſurface of the ſecond was ſmooth and ſoft, its membranes thin, and more inclining to the common make of that of carnivorous animals; the third was ſomewhat like the former, but thicker, and internally had large *Plicæ* or folds: Dr. *Grew* obſerves, that in the common hog, againſt the *Pylorus*, a round caruncle ſtands, as big as a ſmall filberd-kernel, like a ſtopple to the *Pylorus*, for preventing, as he conjectures, a too ſudden and copious eruption of the aliment; this is ſufficiently provided for in our ſubject, by the great ſtraitening of the *Pylorus* here, and the great aſcent it muſt make, before it can get out; and this may alſo account for the ſeveral cells or partitions, *viz.* that the food may be the better digeſted and macerated; for this animal being frugivorous, graminivorous and carnivorous too, the ſtomachs are ſo contrived, that as the firſt, by its inward pellicle, reſembles ſomewhat that of birds, which are carpophagous, ſo the others, thoſe of quadrupeds.

The ſmall guts, which in other animals, being faſtened to a large meſentery, do uſually hang down, were here cloſer gathered to the ſpine, by the ſhortneſs of this membrane; and the colon, which in others, is more ſuſpended, does here by its peculiar ſtructure lie looſe, and fall down; for the *Duodenum* ariſing from the *Pylorus* with a ſhort turn, that and the other ſmall guts made ſeveral convolutions and windings; and altho' the meſentery was but very ſhort from the ſpine, and its circumference ſeemingly but very ſmall, yet in this compaſs it contained 27 foot of theſe inteſtines; for ſo much they meaſured from the *Pylorus* to the *Colon*; the *Colon* was not faſtened to the periphery or rim of the meſentery as uſual, but ariſing from the centre or middle, it made a ſpiral line, its extremity hanging looſe, and its windings were cloſely united to each other by membranes; this *Colon* was very large in compariſon of the other guts, and meaſured 9 foot in length; it had a ſhort *Cæcum*, but pretty wide, and filled with *Fæces*; what Dr. *Grew* obſerves, *viz.* that it is peculiar to the *Cæcum* of a hog and that of a horſe to have the ſame ſtructure with the *Colon*, holds alſo here; and it may be reckoned as an appendix of the *Colon*: The *Meſeraic* veſſels were alſo very extraordinary; for here was obſerved a large vein and artery, running a ſmall and equal way from the inteſtines, and from them there aroſe an infinite number of ſmaller, but ſtreight veſſels, which, proceeding regularly and in great numbers to the guts, afforded a very pleaſant proſpect.

The ſpleen was about ten inches long, and almoſt of the ſame breadth throughout, and in the middle it was one inch and a half broad, of a lead colour, and a little ſpeckled or marbled: The liver conſiſted of four large lobes, and of a dark red colour; it appeared plainly glandulous, and without a *Veſica Fellea*, but it had a *Ductus Bilarius*, which went from the liver to the *Duodenum* as uſual: The *Pancreas* was about five or ſix inches long, and conſiſted of ſeveral glands.

The *Teſtes* were two inches long, larger at the upper than lower end, and about an inch broad in the middle; they were placed in the *Scrotum*; their colour was white, their ſtructure cloſe, ſo that the veſſels, which compoſed them, did not ſo plainly appear, as in an ordinary boar; yet no doubt their whole compages was vaſcular, tho' here cloſer wrought together and united; their uſe, no doubt, is to prepare the *Semen*, which is conveyed thence by the *Vaſa Deferentia* to the *Veſiculæ Seminales*; theſe *Deferentia* ariſe near the lower part of the *Teſtes*, and are inſerted in ſuch a manner, as that they may equally empty themſelves either into the *Veſiculæ Seminales* or the *Urethra*: The *Veſiculæ Seminales* were one inch and a half long; in ſome places a quarter, in others half an inch broad; tho' called *Veſiculæ*, yet here they appeared more glandulous, nor was their cavity any thing conſiderable in largeneſs; the common orifices to them, and the *Vaſa Deferentia* made a ſwelling in the inſide of the *Urethra*, which *De Graef* calls *Caput Gallinaginis*: In other animals at this place is ſeated that glandulous body, called the *Proſtatæ*; but the *Veſiculæ* here being ſo glandulous, poſſibly they may perform their office; unleſs we ſhould aſcribe their uſe to thoſe two glands, which lay on each ſide the *Urethra*, and emptied themſelves by two orifices near the root of the *Penis*; theſe glands were cylindrical, of a whitiſh yellow colour, an inch and a half long, and three eights of an inch in diameter; their ſubſtance was cloſe like that of the *Teſtes*, without any perceptible cavity, and they lay along the outſide of the *Urethra*, reaching from the *Muſculi Erectores Penis* to the glandulous *Veſiculæ* before deſcribed: The *Penis* was a long ſlender body, made up of ſeveral muſcles, whereof two were very long: The *Veſica Urinaria*, or bladder of urine, was rounder than in ſome other animals, where uſually it is more oblong; the *Ureters* were inſerted at the neck of the bladder.

In the *Thorax*, the make of the *Aorta* was uncommon; for in other animals, as it deſcends along the ſpine, its trunk is almoſt of an equal bigneſs, only a little tapering downwards; but in this ſubject, between the heart and its branchings into the iliac arteries, there were three large aneuriſms or tumours; the largeſt was that neareſt the heart, which, after a ſmall contraction,

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traction, emptied itſelf again into the ſecond; and this, tho' ſomething leſs than the firſt, was yet much larger than the third, which was near the diviſion of the *Aorta* into the *Rami Iliaci*; two of theſe ſwellings were opened, and within there were found ſeveral cells, or hollows, and the membranes were here altogether as thick, as where the artery was not extended.

The aperture of the eye was but ſmall, as in the hog-kind; the *Membrana Nictitans* was plainer than uſually it is in quadrupeds; the muſcles were not ſo diſtinct as in ſome brutes; and hence the motion of their eyes is neither ſo quick, nor regular; the pupil is round; the optic nerve is inſerted almoſt in the axis of the eye, and made a ſmall dint, or impreſſion, on the inſide; the *Choroides* is of a pale violet, or browniſh colour.

Juſt on the ridge of the back, over the hinder legs, is ſeated a glandulous body, called the navel; it is ſo covered by the long briſtles there, that it is not to be obſerved but by opening or ſeparating them with the hand; and then you will find a ſmall ſpace almoſt bare, only beſet with fewer, ſhorter, and finer hairs; and in the middle of it is the protuberant orifice of the gland, by which it diſcharges itſelf of the liquor it ſeparates; this orifice has its lips a little reflected and protuberant above the ſurface of the ſkin; it would eaſily admit of a large probe, which could be turned into ſeveral parts of the gland; upon a gentle preſſure with the fingers, there was obſerved a ſmall quantity of a white yellowiſh juice, and ſome of it of a little darker colour, which yielded a very pleaſant and agreeable ſcent, much like that of muſk or civet; the gland itſelf was ſeated between the ſkin, and ſome part of the *Panniculus Carnoſus*; for in the middle of that part or ſurface, which regarded the back, it was bare, and not covered with that muſcle, only its edges encloſed within it; ſo that in taking off the ſkin, the gland too could eaſily come away with it; however, this muſcle may be aſſiſting to it, by its contractions, to preſs out its liquor, as the ſphincter-muſcle is to thoſe ſcent-bags, placed at the extremity of the *Rectum* of other animals; this gland was of the conglomerate kind, or conſiſting of ſeveral other minute glands; it had no conſiderable *Cyſtis*, or cavity within it, but like the *Pancreas* or ſalival glands, it had ſeveral excretory ducts, which terminating at laſt in one, diſcharged its ſecreted juice by a common orifice: This orifice, having ſomething of a reſemblance to a navel, has impoſed upon almoſt all who have written

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written of this animal, ſo far as to take it for one; and others, who have deviated from this ſentiment, have given quite as abſurd and extravagant conjectures about it: But there is nothing, according to Dr. *Tyſon*, to which it can be more fitly compared than to thoſe ſcent-bags or glands in other animals: In pole-cats, juſt at the extremity of the *Rectum*, are placed two bags, filled with a thick and whitiſh liquor of a very ſtrong ſcent; and this is obſervable in all the pole-cat-kind, as alſo in common cats, in a lion, in a dog, in a fox, *&c.* And in moſt ſpecies of animals there is ſomething analogous obſerved, which gives them their peculiar ſcents, or ſmells; thus in reptiles, as the rattle-ſnake, viper, *&c.* are obſerved in the tail two long bags, which diſcharge their fœtid liquor near the *Rectum*; in ſome animals theſe bags are placed in different parts of the body; in the rumps of birds you will meet with two glands, which have three pipes or excretory ducts, ariſing on the top of them above the ſurface of the ſkin, which diſcharge a fœtid liquor; theſe glands are largeſt in the gooſe and duck-kind, which uſe the water; in turkeys the rump is leſs glandulous, but they have a larger *Cyſtis* within; in the oſtrich the gland lies higher on the back, where it makes two bunches, and under the ſkin is a *Cyſtis* filled with a concreted yellowiſh juice; which is nearly the place, where the gland in the *Mexican* hog was ſeated; again, the muſk-deer has its bag on the belly near the navel: It is true, no author has called the ſcent of the *Tajacu* a perfume; on the contrary, they have all branded it as a ſtench; but even the beſt perfumes have ſometimes the rankeſt ſcent; as civet and muſk itſelf when freſh and green, and in large quantities are no ways agreeable, but very offenſive to the ſmell; and even ambergreaſe itſelf at the firſt, as *Gul. Piſo* aſſures us: Our *Tajacu* therefore, when young, and but a ſmall quantity of this liquor is ſeparated by the gland, may yield little or no ſcent; and foxes, till they are well grown, do not ſtink much; but afterwards, when this liquor is plentifully voided, on account of its copiouſly, thinneſs and fluidity, and conſequently being more volatile, it may ſtrike our organs with ſuch a briſk and ſtrong ſenſation, as to cauſe a pain; whereas a more leiſurely appulſe of its particles from a ſmaller and concreted body may give a pleaſure.

Its *Cranium* ſeemed entire without ſutures; from the noſe to the end of the poll are eight inches and a half; and here the *Cranium* grew very narrow, and then ſpread itſelf again in a triangular form, and made a large hollow behind, where it reſpected the back, and where ſtrong muſcles, and the ligament from the back were inſerted; by which means the head is kept ſo ſtreight up, that when alive, it ſeemed to have but a very ſhort, if any neck at all: The *Porus Auditorius*, or paſſage to the ear, was ſomething remarkable, being placed near the poll; anteriorly in the upper jaw were four teeth, or *Inciſores*; a little further was placed a large flat tuſk, ſharp-edged, and ſtanding outwards; and beyond that, on each ſide, were ſix double teeth, or *Molares:* The lower jaw was ſix inches and a half long, one and a half broad at the firſt double tooth, or grinder, of which there were ſix on each ſide: The bone of the lower jaw, from the *Dentes Molares* to the *Inciſores*, ſeemed ſpongy and carious; and the tuſks in this jaw were rooted out, as were one or two of the inciſors, which in all were about four.

There were ſeven *Vertebræ* of the neck, which meaſured in length four inches and a half; the firſt, or *Atlas*, had two broad tranſverſe proceſſes, but no ſpine; the ſecond had a large ſpine; the third, fourth, and fifth had no ſpines; the ſixth and ſeventh had large acute ones: There were nine *Vertebræ* of the back; the ſpines of the firſt, ſecond, and third were above three inches long; but they gradually decreaſed, as they approached the tail: The firſt *Vertebra* of the *Os Coccygis* was two inches long, and tho' it ſeemed to be ſeveral, it was but one bone: There were about ſix *Vertebræ* more, which ran no farther than the extent of the *Os Iſchii:* There were fourteen ribs on each ſide; the *Sternum* jutted out about an inch beyond the ſetting on of the firſt ribs.

The *Scapula* was five inches long; the *Os Femoris* of the fore-foot, five inches and a half long; the *Os Tibiæ* of the fore foot was about the ſame length in the whole, but from the articulation with the *Os Femoris* to the *Os Metatarſi*, it was but four inches; for from the juncture with the *Os Femoris*, it jutted out farther: The bones of the *Tarſus* were five; of the *Metatarſus*, three, about two inches long; the bones of the *Digiti* nine, there being two to each claw, and three claws to each fore-foot: The *Os Femoris* of the hinder foot was almoſt ſix inches long; and near its articulation with the *Os Tibiæ* it had a ſmall bone, like the *Patella* in the knee of a man: In the leg were two bones, *viz.* the *Foſſile Majus* and *Minus*, 5 ½ inches long; but this part in the fore-leg was only a ſingle bone;

ſingle bone; tho' in a dog, a monkey, and ſome other animals, there are two bones in the fore-leg: The *Os Calcis* was almoſt two inches long; and there were four other bones of the *Tarſus* or inſtep: The *Metatarſus*, or foot, was compoſed of four bones; and the two innermoſt were much the largeſt, being two inches and a quarter long; there were four *Digiti*, and in each three bones, the laſt of which was covered with a nail.

Explication of the figures. Fig. 1. Plate VII. repreſents the natural ſhape of this *Mexican* hog, and the line *a* points to the ſcent-gland.

Fig. 2. The ſceleton; *a* the fore teeth; *b* the tuſk; *cc* the *Molares*, or grinders; *d* the lower jaw; *e* that part of the lower jaw which was carious; *f* the *Cranium*; *g* the orbit of the eye; *h* the *Porus Auditorius*, or paſſage of the ear; *i* the triangular expanſion of the *Cranium* backwards; *k* the *Vertebræ* of the neck; *ll* the *Vertebræ* of the back and loins; *m* the *Vertebræ* of the *Os Coccygis*; *nn* the ribs; *o* the protuberant bone of the *Sternum*; *p* the *Scapula*, or ſhoulder-blade; *q* the *Os Iſchii*; *rr* the *Os Femoris*; *s* the *Patella* of the hinder legs; *t* the *Tibia* of the fore-leg; *v* a large protuberance of the *Tibia*; *w* the *Tibia*, or *Focile Majus* of the hinder leg; *x* the *Fibula*, or *Focile Minus* of the hinder leg; *yy* the *Tarſus*, or inſtep in both legs; *z* the calx or heel in the hinder leg; ααα the bones of the *Metatarſus*, or foot; βββ the *Digiti* or toes; γγγ the nails.

Fig. 3. The orifice of the ſcent-gland, as it naturally appeared on the outſide of the ſkin of the back; a little ſpace round this orifice was almoſt bare of briſtles.

Fig. 4. The ſcent-gland itſelf, which was of the conglomerate kind.

Fig. 5. Moſt of the *Viſcera*; *a* the *Oeſophagus*, or gullet; *b* the firſt ventricle or ſtomach; *c* the ſecond ventricle or ſtomach; *dd* the *Cornua*, or horns of the ſecond ſtomach; *e* the third ſtomach; *f* the *Pylorus*; *ggg* the ſmall guts; *hhh* the *Colon*; *i* the *Cæcum*; *k* the *Rectum*; *l* the meſentery; *mm* the meſeraic veſſels; *n* the *Pancreas*; *o* the ſpleen; *p* the liver; *q* the *Ductus* of the gall, from the liver to the *Duodenum*.

Fig. 6. The outſide of the three ſtomachs, more in their natural ſituation; *a* the gullet; *b* the firſt ſtomach; *c* the ſecond ſtomach; *d* the third ſtomach; *e* the *Pylorus*; *fff* the blood-veſſels.

Fig. 7. The ſtomach opened; *a* the gullet; *b* the entrance of the gullet into the firſt ſtomach; *cc* the inſide of the firſt

ſtomach, which was inveſted with a ſtrong, thick, white pellicle or membrane; *dd* the ſecond ſtomach; *ee* the third ſtomach, in which were ſeveral remarkable folds; *f* the *Pylorus.*

Fig. 8. The genital parts, and the bladder; *a* the bladder of urine; *b* the neck of the bladder; *cc* the *Ureters*; *dd* the *Teſtes*; *ee* the *Vaſa Deferentia*; *ff* the *Veſiculæ Seminales*, which here were glandulous; *g* the *Caput Gallinaginis*, where the *Veſiculæ Seminales* and *Vaſa Deferentia* empty themſelves into the *Urethra*; *hh* two glandulous bodies, which may poſſibly be reckoned the *Proſtatæ*; *i* the orifices, by which theſe glandulous bodies diſcharge themſelves into the *Urethra*; *k* the *Urethra* opened; *l* the *Penis*; *mm* the two muſcles belonging to the *Penis*; *nn* other muſcles aſſiſting the ſame.

Fig. 9. The heart, and the aneuriſms of the *Aorta*, or great artery; *a* the heart; *bb* the aſcending branches of the great artery; *c* the deſcending trunk of the *Aorta*; *d* the firſt aneuriſm, or diſtenſion of the great artery opened, to ſhew its ſeveral cells; *e* a contraction of the artery again; *f* the ſecond aneuriſm likewiſe opened; *g* the third and ſmalleſt aneuriſm; *hhh* the iliac branches of the *Aorta.*

The Antiquity of the numeral Characters; *by Dr.* Wallis. Phil. Tranſ. N° 154. p. 399.

IT is generally agreed, that the numeral characters now in uſe, with the manner of computation by them, and the names of *Algoriſm* appropriated to that way of computation, came to us from the *Arabs*, but ſomewhat altered as to the ſhape of the figures in ſucceeding ages, and to the *Arabs* from the *Indians*; but it is not ſo generally agreed, of what antiquity they have been in *Europe: Jo. Gerard Voſſius*, in his book *de Scientiis Mathematicis*, thinks that they came not to be uſed till about the year of our Lord 1300; or at moſt, not more early than the year 1250: And *P. Mabillon de Re Diplomatica* tells us, that he did not find them uſed any where ſooner than the 14th century; but Dr. *Wallis* is of opinion, that they are as old at leaſt as the times of *Hermannus Contractus*, who lived about the year 1050; if not ſo frequently in ordinary affairs, yet at leaſt in mathematical writings, and eſpecially in aſtronomical tables; and he did not remember to have ſeen any monument of them more ancient, than the mantle-tree of the parlour chimney, in the houſe of Mr. *Will. Richards*, rector of *Helmdon* in *Northamptonſhire*, which is of wood; it was all over as black as ink, having contracted that colour by age and ſmoke; and he thinks it might laſt for many hundreds of years to come, having no ſign of rottenneſs, or any tendency thereto; it was five foot nine inches in length; its breadth, or depth, at the ends A B, Fig. 10. Plate VII. was 11 $\frac{1}{2}$ inches, but in the middle C D ſomewhat leſs: On the front of the upper part, beginning at the middle, there was, on three ſquares, ſeparated from each other by a deep furrow or channel, the date when it was firſt made, as the doctor ſuppoſes, partly in *Roman*, and partly in numeral characters, *viz.* A^{o} Do^{i} M^{o} 133; on a fourth ſquare was a flower, and on a fifth the two letters W. R. with an eſcutcheon, poſſibly the name of the then proprietor; both the letters and the figures are of an antique form, agreeing well enough with that age; they are not engraven, or cut in, but prominent on their ſeveral ſquares, by way of *bas relief:* The o over the A is a round o, but that over the M is a ſquare o: Hence it appears, that the uſe of ſuch figures here in *England*, even on ordinary occaſions, is at leaſt as old as the year 1133: And Dr. *Wallis* thinks they are ſtill ſomewhat more ancient, becauſe the ſhape of the figures, tho' not arrived exactly to the ſhape now uſed, was even then conſiderably varied from the ſhape of the *Arabic* figures; which ſhews they had then been for ſome time in uſe; ſuch change of ſhape in figures and letters coming on gradually: It need not cauſe any difficulty that part of the date is expreſſed by the numeral letter M, or the word *Milleſimo*, whereof M^{o} is but a contraction, while the reſt is expreſſed in numeral characters; for the ſame thing does often occur in old manuſcripts, and ſometimes even at this day; and this rather favours of the ſimplicity of that age, than of any deſign of impoſture.

An Account of Pruſa *in* Bithynia, *and the Obſervations in* Turky *continued; by Dr.* Tho. Smith. Phil. Tranſ. N° 155. p. 431.

MOntanea, formerly called *Nicopolis* according to *Bellonius*, or rather *Cios*, whence the bay is called *Sinus Cianus*, lies in the bottom of a bay about 80 miles from *Conſtantinople*, and is the ſcale or landing-place for *Pruſa*, from which it is diſtant about 12 miles, in the mid-way to it is the village *Mouſſanpoula*.

Pruſa, now called by the *Turks*, *Burſia*, the metropolis of *Bithynia*, is ſeated partly at the foot, and partly on the riſing of mount *Olympus*, one of the higheſt hills of the *Leſſer Aſia*;

its top is covered with ſnow for nine or ten months of the year; ſeveral ſtreams of water do continually run down the hill, and are accounted very unwholeſome on account of the ſnow mixing therewith: In the upper part of the city to the north-weſt, ſtands the ſeraglio, which is walled round; but the emperors not reſiding here ever ſince their acquiſitions in *Thrace*, or ſcarce viſiting this imperial city, and none of their ſons living here, according to the policy of the former emperors, who did not permit their ſons, when grown up, to be near them, but ſent them to ſome honourable employment, accompanied with a baſhaw and cadi to inſtruct them in the arts of war and government, it now lies neglected and deſpoiled of all its ornaments; here alſo are the ſepulchre of *Oſman*, the founder of the family which now reigns, *viz.* 1683, and his ſon *Urchan*, who took the city, near a moſque, formerly a *Chriſtian* church, dedicated to St. *John*, and where was a convent of Religious built by *Conſtantinus Iconomachus*, where Dr. *Smith* ſaw the figure of a croſs ſtill remaining upon the wall; here is hung up a drum of a vaſt bigneſs, ſuch as they carry on the backs of camels, and poſſibly one of thoſe uſed in taking the place: In the lower part, near the bottom of the hill, *Morad* II. the father of *Mahomet the Great*, lies buried, near which ſtood formerly the metropolitan church of the holy apoſtles: The *Bezeſten*, or Exchange, ſeems to be much better and larger than the great one at *Conſtantinople*, as are ſeveral Caravanſera's built for the uſe and accommodation of merchants and travellers: Without the city, towards the eaſt, ſtand the moſque and ſepulchre of the emperor *Bajazet* I. whom the *Turks* call *Jilderim*, or lightning, and the *Greek* writers Λαιλαψ, or tempeſt; not far from thence is the moſque of *Mahomet* I. and his ſepulchre; towards the weſt, upon the ſide of the hill, ſtands the moſque of *Morad* I. whom they call *Gazi*, or the conqueror, and near which he lies buried; there are in all about 124 moſques, ſeveral of which were formerly *Chriſtian* churches; and between 50 and 60 *Chanes*; the caſtles built by *Oſman*, when he beſieged the city, lie neglected and unfortified, the one to the north, the other to the ſouth-weſt: At *Checkerghe*, about a mile and a half out of town, are the hot-baths, much frequented both by *Chriſtians* and *Turks*; they are made very convenient to bathe in, and covered over, that they may be uſed at all ſeaſons; and there is a large baſon, where they uſually divert themſelves by ſwimming.

As

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As to the opinions the *Türks* entertain of our bleſſed Saviour and the chriſtian religion; they confeſs that Chriſt was born of a pure ſpotleſs Virgin, the Virgin Mary, choſen by God, and ſanctified above all other women, and that the angel *Gabriel* was ſent from heaven to acquaint her therewith; that this miraculous and ſupernatural birth was peculiar to Chriſt alone, and that he was conceived by the Holy Ghoſt; that he wrought mighty miracles; for inſtance, that he cleanſed lepers, gave ſight to the blind, reſtored the ſick to their health, and raiſed the dead; that he is a great prophet, ſent by God to convert men from the vanity and error of their falſe worſhip to the knowledge of the true God, to preach righteouſneſs, and to correct and reſtore the imperfection and miſcarriages of human nature; that he was of a moſt holy and exemplary life; that he was the true word of God, the apoſtle or ambaſſador of God; that his goſpel was revealed to him from Heaven, and that he is in Heaven ſtanding near the throne of God: It is true, they blaſpheme, with a brutiſhneſs and ſtupidity only befitting *Turks*, the myſteries of the Holy Trinity, and of the divinity of our bleſſed Saviour; and deny that he was put to death, holding that another was crucified by the *Jews* in his ſhape, but that he himſelf was aſſumed bodily into heaven without dying at all; and conſequently they deny that he ſatisfied divine juſtice for the ſins of the world; ſo great an affinity is there between the hereſy of *Socinus*, and profeſſed mahometaniſm.

Dr. *Smith* could never obſerve any *Turkiſh* tranſlation of the *Alcoran*, which they mightily cry up for the elegance of its ſtile; for it being enthuſiaſtic and high-flown, and abounding in jingling periods, they are greatly taken therewith; but poſſibly it is more out of political views that they do not tranſlate it into their vulgar language, than any reſpect to the ſacredneſs of the original; *viz.* that it may be in the greater veneration among the people, who might be apt to ſlight and diſeſteem it; it is enough that the prieſts and learned men explain the difficult paſſages thereof to the people, and write commentaries for the uſe of the more curious and inquiſitive: The *Perſians*, on the contrary, think it no diſparagement to the *Arabic*, or a profanation of the ſenſe, to tranſlate it into their own language; and copies of it are frequent amongſt them.

The Grand Seignior's women are uſually the choiceſt beauties of the chriſtian ſpoils, which are made preſents of, either by the *Baſhaws* or *Tartars:* The *Baſhaws* are generally the ſons of chriſtians; taken into the ſeraglio near the emperor's perſon, and ſo they are preferred to conſiderable governments, or elſe they raiſe themſelves by their valour and conduct: *Mahomet Baſhaw* in the time of *Achmet*, whoſe eldeſt daughter he married, was the firſt natural *Turk*, that was made chief vizir: The chief vizir *Mahomet Kupriuli*, who ſettled the empire, when it was ready to be ſhaken to pieces, and diſſolved by ſeveral powerful factions in the ſtate, and by the mutinies and diſcontents of the *Janizaries* and *Spahis*, was by birth an *Albaneſe*, the ſon of a *Greek* prieſt; he forbad the derviſes to dance in a ring and turn round, as they were formerly wont to do on ſet times before the people, till they became giddy by this circular motion, and fell in a ſwoon; and often, upon their recovery from ſuch trances, they pretended to revelations; the prieſts have no great regard to his memory, looking upon him as a man of little or no religion; and they give out, if he had lived, he would have forbid their calling to prayers from the ſpires of their moſques, and hanging out lamps; both which they look upon as ſolemn and eſſential to the exerciſe of religion, but he, as the effect of bigotry and ſuperſtition.

The *Turks* have a great regard for phyſicians; for tho' they are of opinion, that they cannot with all their art prolong life, its period and term being fatal and abſolutely determined by God; yet they often conſult them upon any violent ſickneſs or pain, in order to make the time allotted them in the world more pleaſant and eaſy; it is very rare that a natural *Turk* makes phyſick his profeſſion and ſtudy; their phyſicians are generally *Greeks* and *Jews*.

They have little of ingenious or ſolid learning amongſt them; their chief ſtudy next to the *Alcoran* being metaphyſical niceties about the attributes of God, or other ſpeculative notions derived down to them from ſome of their famed maſters, and holy men, whom they pretend to follow: Their knowledge of the motion of the heavens, for which the *Arabians* and other eaſtern nations were ſo deſervedly famous, as their aſtronomical tables of the longitude and latitude of the fixt ſtars, and of the moon's appulſe to them, fully evince, is now very mean, and chiefly ſtudied for the uſe of judiciary aſtrology; the great inſtrument they uſe is an aſtrolabe, with which they make very imperfect obſervations, having no ſuch thing as a quadrant or ſextant, much leſs a teleſcope, or any mechanical inſtrument to aſſiſt them in their calculations: Their ſkill in geography is as inconſiderable: They have no genius for navigation, and conſequently they are very raw and unexperienced in that art, ſcarce venturing to ſail out of ſight of land: A *Turkiſh* compaſs conſiſts only of eight points; *viz.* the four cardinal and the four collateral; they are at a mighty loſs how to ſail by a ſide-wind, when by hauling their ſails ſharp, they might lie their courſe, and much more when they are in the wind's eye; not knowing how to make tacks or boords, but chuſe rather to put into ſome neighbouring port, till the wind blow fair.

They never trouble themſelves with reading the hiſtories of other nations, or of ancient times, much leſs with the ſtudy of chronology, without which hiſtory is very lame and imperfect; which is the reaſon of thoſe ridiculous and childiſh miſtakes, which paſs current and uncontradicted amongſt them; for inſtance, they make *Job* one of *Solomon*'s judges, and *Iſcander*, by whom they mean *Alexander* the *Great*, captain general of his army; they reckon *Philip* of *Macedon* among the anceſtors of our bleſſed Saviour, and believe that *Sampſon*, *Jonas* and St. *George* were his cotemporaries: In this they are more excuſeable than their falſe prophet *Mahomet*, who in his *Alcoran* has perverted ſeveral hiſtorical notices in the writings of the old teſtament, and is guilty of vile and abſurd pſeudochroniſms: To remedy this defect, of which he was very ſenſible, and the better to underſtand the ſtate of chriſtendom, and the particular kingdoms and republicks of it, the great and wiſe vizir *Achmet* made his interpreter *Panagiotti*, a learned *Greek*, at leiſure hours, even at the ſiege of *Candia*, as well as at other times, read ſeveral ancient hiſtories to him, and render them *ex tempore* into the *Turkiſh* language, and particularly *Blaeu*'s *Atlas*, with which he was mightily taken.

Tho' their year be according to the courſe of the moon, and conſequently the *Turkiſh* months run round the civil year in a circle of 33 years and ſome odd days; yet they celebrate the *Neuruz*, which in the *Perſian* tongue ſignifies the new year, the 21ſt of *March* (on which day the vernal equinox was fixed by the *Greeks* and other oriental Chriſtians in the time of *Conſtantine*, who made no proviſion for the preceſſion, which in proceſs of time the inequality between the civil and aſtronomical year muſt neceſſarily produce) at which time the *Cadi*'s, and other annual magiſtrates and farmers of the cuſtoms take place, and reckon to that day twelve-month again.

In their civil deportment and behaviour towards each other, the left hand is the more worthy and honourable place, except among their eccleſiaſticks; and the reaſon they alledge is, that they write from the right hand, and the ſword is worn on the left ſide, and ſo is more at the perſons diſpoſal who walks on that hand; the chief vizir accordingly in the divan ſits on the left hand of the mufty, each maintaining their right of precedence according to this way of deciſion: In their moſques they ſit without any diſtinction of degrees: Some of the more zealous *Turks* cauſe to be engraven on their ſcimiters and bucklers a ſentence out of the 61ſt *Surat*, which is concerning fighting, or battle array, and contains encouragement to fight *in the way and path of God*, as the impoſtor expreſſes it; for which, he aſſures them, that, beſides aſſiſtance from heaven in obtaining victory, God will pardon their ſins, and bring them to paradiſe; thus ſpirited with zeal, a *Turk* lays about him with fury, and ſeems ambitious of dying, to gain the delights of paradiſe; at leaſt he is indifferent whether he lives or dies.

The *Turks*, as to their temper, are ſerious, or rather inclining to moroſeneſs; they ſeldom laugh, becauſe it is reckoned an indication of great vanity and lightneſs: They perform the exerciſes, which they uſe for diverſions, as ſhooting and hunting, with a great deal of gravity, as if they deſigned them more for health than for pleaſure, and they indulge themſelves therein but ſeldom; the better and richer ſort, who have nothing to do, ſit all day at home, lolling upon a ſofa, or raiſed place in their rooms, and taking tobacco, which their ſlaves fill and light for them; and if they retire in the ſummer or autumn for a week or fortnight to ſome convenient fountain in a wood with their women, it is chiefly to enjoy the refreſhments of a cool air; it is true, in times of triumph, for ſome great ſucceſs obtained over the Chriſtians, when the ſhops are open for three nights together, and hung with lights, as well as the ſpires of their moſques in curious figures, they run into extravagant mirth, running up and down the ſtreets in companies, and ſometimes ſinging and dancing in their rude manner; but when this fit is over, they ſoon return to their former melancholy: In their coffee-houſes, where they uſe to reſort to tipple, there is uſually one hired by the owners, to read either an idle book of tales, which they admire as wit, or filthy obſcene ſtories, with which they ſeem wonderfully affected and pleaſed, few of them being able to read; theſe are the ſchools

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which they frequent for their information; tho' in time of war, when things ſucceed ill with them, their diſcourſe turns upon bad government; and then neither the Grand Seignior himſelf nor his miniſters eſcape their cenſures; and the wiſe vizir, during the war at *Candia*, ſeeing the bad conſequences of ſuch meetings and diſcourſes, commanded that all the publick coffee-houſes ſhould be ſhut up in *Conſtantinople* and ſeveral other great cities of the empire, where the malecontents uſed to cabal, and paſs cenſures upon every ill ſucceſs and miſcarriage in the adminiſtration of affairs.

The cuſtom of the *Turks* to ſalute the emperor, or the vizir baſhaws with loud acclamations and wiſhes of health and long life, when they appear firſt in their houſes, or in any publick place, is derived from the *Greeks*, who borrowed it from the *Romans*; this was done in a kind of ſinging tone; whence *Luitprandus* biſhop of *Cremona* tells us, that in a certain proceſſion, at which he was preſent, they ſung to the emperor *Nicephorus* πολλα ἔτη, many years; which *Codinus*, who lived about the time of the taking of *Conſtantinople* by the *Turks*, expreſſes by το Ψαλλειν το πολυχρονιον, or by πολυχρονιζειν, and the wiſh or ſalute itſelf by πολυχρονισμα.

The *Turkiſh* coin is poor and inconſiderable, not only on account of their want of bullion, but of their little ſkill in matters relating to the mint; hence it is, that *Zecchines* and *Hungars*, ſtamped in chriſtendom paſs current for gold, and *Spaniſh Dollars* and *Zellets* for ſilver, and moſt of the great payments are made in them; either thro' ignorance or ſloth not caring to follow the example of the *Indian* or *Perſian* emperors, who uſually melt down the money imported from chriſtendom by the merchants, and give it a new ſtamp; the moſt uſual pieces are the *Seriphi* of gold, ſomewhat leſs in value than a *Venetian Zecchine*; and *Aſpers*, ten of which are equal to *Six-pence Engliſh*; and ſome few three *Aſper* pieces; a *Mangar* is an ugly old copper piece, eight of which make but one *Aſper*, and ſeems rather to be a *Greek* than *Turkiſh* coin; they have no arms on their coins, only letters emboſſed on both ſides, expreſſing the emperor's name, or ſome ſhort ſentence out of the *Alcoran*.

The *Turks* look upon earthquakes as ominous, as the vulgar do eclipſes, not underſtanding the philoſophy of them.

Their puniſhments are very ſevere, this being judged the moſt effectual way to prevent all publick diſorders and miſchiefs; they uſe no great formality in their proceſſes; if the criminal be taken in the fact, and the witneſſes ready and preſent to atteſt it, and ſometimes if there be but probable circumſtances, without full convictions, they condemn him; and ſoon after ſentence, ſometimes in an hour or leſs, they hurry him away to execution: Hanging is the uſual death for an ordinary crime; but for robbery and murder committed on the high-way by ſuch as rob in parties and alarm whole provinces; or for ſacrilege; or any heinous crime againſt the government, either *gaunching*, or eſcoriation, or cutting off the legs and arms, and leaving the trunk of the body in the high-way, or empaling, which is thruſting an iron ſtake thro' the body, which comes out either under the neck, or at the mouth; in which extreme torment the wretch may live two or three days, if the guts or heart happen not to be wounded by the pointed ſpike in its paſſage; this puniſhment ſeems to have been in uſe among the *Romans*, as appears from *Seneca*, epiſtle 14th, and from his book *de Conſolatione Cap.* 20. Murder is ſeldom pardoned, and eſpecially, if the relations of the murdered perſon demand juſtice.

Circumciſion, tho' a ſacred rite, is performed in their private houſes, and never in their moſques.

The women colour their eye-brows and eye-lids with an ugly black powder, and their nails with the powder of *Kanna*, which gives a faint red tincture, like brick, as they alſo do the tails and hoofs of horſes, which they look upon as a great ornament: Their great diverſion is bathing, ſometimes thrice, if not four times a week; they are not permitted to go to church in time of prayer, for fear of marring their devotion; the *Turks* being of ſo brutiſh a temper, that their luſt is excited at the ſight of a beautiful object: They are often called by the name of flowers and fruits, and ſometimes they give them fantaſtic names, ſuch as *Sucar Birpara*, or bit of ſugar, *Dil ſerib*, or raviſher of hearts, and the like.

Their ſkill in agriculture is very mean; in their gardens they have ſeveral little trenches to convey water where it may be moſt neceſſary for their plants and flowers; they know little or nothing of manuring their grounds; they ſometimes burn their fields and vineyards after harveſt and vintage, partly to deſtroy the vermin, and partly to enrich the ſoil; they tread out their corn with oxen, by drawing a ſquare plank board about a foot and a half, or two foot over, ſtudded with flint; and they winnow it in the open air on their threſhing-floors; they feed their horſes with barley and chopped ſtraw, for

Dr. *Smith* does not remember to have ſeen any oats amongſt them; and they make but little hay: For great draughts they make uſe of buffalo's in their carts: Camels can travel four days an end without water, and they will eat tops of thiſtles, ſhrubs or any kind of boughs; they are very ſure-footed, and kneel when they are a-loading; they live to a great age, ſome even to 60.

The chief furniture of their houſes are carpets or mats of *Grand Cairo*, neatly wrought with ſtraw, and ſpread upon the ground; they have no occaſion for chairs, couches, ſtools or tables; their poſtures within doors being different from ours; they have no hangings, but their walls are whited, ſet off with painting and adorned with a kind of porcelane; they have no beds with curtains.

They ſeal not with wax, but ink at the bottom of the paper; the emperor's name is uſually written with flouriſhes, and in perplexed characters; they have no coats of arms on their ſeals, there being no ſuch thing as gentility among them.

Some of them, notwithſtanding their zeal for *Mahomet*, and the religion by him eſtabliſhed, retain not only a favourable and honourable opinion of our bleſſed Saviour, but even place ſome kind of confidence in the uſe of his name, or in the words of the goſpel, tho' it may ſeem to be wholly out of ſuperſtition; thus, in their amulets, which they call *Chaimaili*, being little bits of paper two or three fingers breadth, rolled up in pieces of ſilk, containing ſeveral ſhort prayers and ſentences out of the *Alcoran*, with ſeveral circles and other figures, they uſually inſcribe the holy and venerable name of JESUS, or the figure of the croſs, or the firſt words of St. *John*'s goſpel, and the like; and they hang them about their necks, or place them under their arm-pits, or in their boſoms near their hearts (being the ſame with what the *Greeks* call εγκολπια) and eſpecially when they go to war, as a preſervative againſt the dangers thereof; and indeed againſt any misfortune whatever; ſome have them ſewed within their caps: Others again are ſuch bigots in their religion, and ſo furious againſt chriſtians, that they not only treat them with all imaginable ſcorn and contempt, but take it ill to be *Salamed* or ſaluted by them; as if it were the effect of ſaucineſs, or an unbecoming familiarity: Their reſpect for the *Alcoran* is extraordinary; they dare not open the leaves thereof with unwaſhen hands, according to the advice or command written in *Arabic* upon the cover; *Let no one touch this book, but he that is clean*;

they kiſs it and bend their heads, and touch their eyes with it, both when they open and when they ſhut it.

The *Janizaries*, when they attend upon chriſtian ambaſſadors to their audience, ſeem to appear in their bravery, and in a habit far different from that of ſoldiers, without either fire-arms or ſwords (which latter are only worn in time of ſervice, or when they are upon a march, or when embodied) wearing a cap made of camels hair, with a broad flap dangling behind, a gilt embroidered wreath running round it, and an oblong piece of braſs riſing up from the middle of their forehead near a foot, with a great club in their hand, like inferior officers of the civil government; but when they are in the camp, they throw off their upper veſt and turbants, and put on a *Feſs*, or red cap, which ſets cloſe to their head, and they tuck up their *Duliman* or long coat to their girdle, that they may be the more quick and expeditious in their charge.

They affect finery and neatneſs in their cloaths and ſaſhes; and in rainy and ſuſpicious weather, they are very careful how they go abroad without their *Yamurlicks*, a kind of coat they throw over their heads at ſuch times.

Their pans and diſhes are for the moſt part of copper, but ſo neatly tinned over, that they look like ſilver..

There are thouſands of *Gypſies*, or *Zinganies* in *Turkey*, who live the ſame idle kind of life they do in Chriſtendom, and pretend to the ſame art of telling fortunes, and they are looked upon as the refuſe of mankind; it is accounted the greateſt degree of human miſery to be a ſlave to any of theſe creatures.

The *Haggai* or pilgrims, that have been at *Mecca* and *Medina*, forbear to drink wine in a very religious manner, out of a perſuaſion that one drop would efface all the merits of that troubleſome and expenſive journey; and ſome have been poſſeſſed with ſuch a mad zeal, that they have blinded themſelves, after having been once bleſſed with the ſight of *Mahomet*'s ſepulchre.

After *Jatzib*, that is an hour and half in the night throughout the whole year, there is as great a ſilence in the ſtreets as at midnight, the emperor *Achmet* in 1611 having made an order, that none ſhould preſume to be out of his houſe after that time, and this is punctually obſerved to this day; the *Boſtangi Baſhi*, who commands all the *Agiamoglans* in the Seraglio, the *Topgi Baſhi*, or ſuch great officers, attended with armed men, walk the rounds and drub ſuch as they find abroad at unſeaſonable hours, of what nation or quality ſoever, except phyſicians, ſurgeons, and apothecaries, who are allowed to viſit the ſick.

The *Turkmans* (for ſo they are peculiarly called, as if they were the true deſcendents of the old *Turks*, or *Scythians*) have no fixed abode, but travel with their families and cattle from place to place, carrying their wives and children upon camels; they pitch their tents uſually near rivers and fountains for the conveniency of water; and according as their neceſſities require, making a longer or ſhorter ſtay; their whole eſtate conſiſts in their numerous flocks and herds, which they ſell upon occaſion to ſupply themſelves with what they want, at the towns they paſs thro'; their only concern is how to enjoy the benefits and bleſſings of nature, without the troubles and diſquiets of life, being contented and happy in one another's company, void of all ambition and envy, courteous and human to ſtrangers, that may want their help and aſſiſtance, kindly entertaining them with ſuch proviſions as their folds afford; the country lies open without any encloſures, and the property not being veſted in any one, they travel thro' the plains unmoleſted, and find excellent paſturage every where: The *Turks* will till no more ground then will ſerve their neceſſities, being ſupplied with corn from *Egypt*, *Moldavia*, and *Walachia*, by the way of the *Black-Sea*, and vaſt tracts of ground lie waſte and uncultivated; ſo that their ſloth is ſometimes juſtly puniſhed with dearths.

They have nothing to ſhew for their houſes and poſſeſſions, but an *Hogiet*, or piece of paper ſubſcribed by the Cadi, if they have acquired them with their money, or that they were their father's before them.

The *Derviſes* are generally melancholy, and place the greateſt part of their religion in abſtinence, and other ſeverities; ſome cut their fleſh, others make vows not to ſpeak for ſix or ſeven years, or all their lives long, tho' never ſo much provoked or diſtreſſed; their garments are made of a coarſe ſort of wool, or goat's hair; they are, by the vow of their order, tied up from ever marrying; ſeveral of this ſect, in the height of their religious phrenzy, have attempted upon the lives of the emperors themſelves upon any diſguſt at their government.

They pay a mighty veneration to any relique of *Mahomet*; his banner is ſtill preſerved in the treaſury of the ſeraglio, and looked upon as the great ſecurity of the empire; they believe that it was ſent from heaven, and conveyed into the hands of

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Mahomet by the angel *Gabriel*, as a pledge and ſign of victory and ſucceſs in his battles againſt the *Chriſtians*, and all other enemies of the muſſulman faith; it was ſent to *Candia* to encourage the ſoldiers to endure the fatigue of that long and tedious ſiege; and when it was brought thence, after the ſurrendry of the city, to be depoſited in its uſual place, the vizir gave ſeveral *Chriſtian* ſlaves their liberty, who rowed in the galley fraught with this ſacred relique; they pretend to have ſome rags of *Mahomet*'s veſt, to which they aſcribe great virtue.

Next to the *Maſtil*, or *Cadaleskines*, are the *Molla*'s, of which the four following are the principal, *viz.* the *Molla* of *Galata*, *Adrianople*, *Aleppo*, and *Pruſa*; and after them are reckoned theſe eight, *viz.* of *Stambol*, *Ephendi*, *Lariſſa*, *Miſir* or *Cairo*, *Sham* or *Damaſcus*, *Diarbekir* or *Meſopotamia*, *Cataia*, *Sophia*, and *Philippi*.

The prieſts have no habit peculiar to their profeſſion, whereby they are diſtinguiſhed from others; if they are ejected their moſques for miſcarriage or neglect of their duty, or if they think fit to reſign, and be prieſts no longer, they may betake themſelves, without any ſcandal, to ſecular employments, their former character and quality wholly ceaſing; while they remain prieſts, they put on a more than ordinary gravity in their diſcourſe and gate, and affect to wear turbants ſwelling out, and conſiſting of many croſs folds.

In *Bairam* time, which is the great feſtival of the year, and when every one looks chearful and gay, among other ſigns of mutual reſpect, they ſprinkle each other with ſweet water; they indulge themſelves in ſeveral ſports; and ſome are mightily pleaſed with ſwinging in the open air, eſpecially the ordinary ſort, paying only a few aſpers for the diverſion.

The government is perfectly arbitrary and deſpotical, the will and pleaſure of the emperor having the power and force of law, and oftentimes is above it; his bare command, without any proceſs, is ſufficient to take off the head of any perſon how conſiderable ſoever, tho' uſually to ſilence the murmurings of the ſoldiery and people, the ſentence is confirmed by the mufti; ſometimes baſhaws, who have amaſſed great treaſures in their government, are cut off in their own houſes amidſt their retinue, the meſſengers of death producing the imperial command, which is uſually ſent in a black purſe, and not a ſword is drawn in their defence; others, if they are obnoxious to the leaſt umbrage or jealouſy, tho' diſmiſſed the ſeraglio with all poſſible demonſtrations of the Grand Seignior's favour, and with rich preſents, in order to take poſſeſſion of places of great command in the empire, before they have got two or three day's journey from *Conſtantinople*, have been overtaken and ſtrangled: In the army preferment is had according to merit; courage and conduct are ſure to be rewarded, the way lying open to the meaneſt ſoldier to raiſe himſelf to be the chief of his order; but other preferments depend upon mere chance, and upon the emperor's fancy, whether the perſon be fit or not, and they are as ſoon loſt: The leaſt ill ſucceſs or miſcarriages proves often fatal, and a more lucky man is put in his place, and he ſucceeded by a third, if unfortunate in a deſign, tho' managed with never ſo much prudence and valour; they admit of no hereditary honours, and have no reſpect to deſcent or blood, except the *Ottoman* family; he only is great and noble, whom the emperor favours, and while his command laſts; according to a tradition which paſſes current amongſt them, a baſhaw's ſon by a ſultana, or a daughter or ſiſter of the emperor, can riſe no higher than to be a *Sangiacbei*, or governour of ſome ſmall province, much inferior to a baſhaw, and under his juriſdiction; being generally born of ſlaves, they do not boaſt of their birth, very few amongſt them being ſcarce able to give any account of their grand-fathers; they have no ſurnames, but are diſtinguiſhed by their poſſeſſions and places of abode; and enjoying by law a liberty of having what women they pleaſe; they have little or no regard to alliance or kindred.

Their empire owes its continuance to the ſeverity of the government, which oftentimes takes place without regard either to juſtice or equity; and to their frequent wars, which prevent all occaſions of mutiny and faction among the ſoldiers, which frequently happen, when unemployed: So that, tho' ambition may put a warlike Sultan upon enlarging his territories by new conqueſts, yet reaſons of ſtate forces a weak and effeminate prince, as *Ibrahim* was, to make war for his own ſecurity: Their politics are not owing to books or ſtudy, or the examples of paſt times, but to experience, and the plain ſuggeſtions of nature and common ſenſe: Their councils formerly were open, and their deſigns known and proclaimed before-hand, as if this had been a bravery becoming their greatneſs, and that they ſcorned to ſteal a conqueſt; but they have ſince learned the art of diſſimulation, and they can lye and ſwear for their intereſt, and ſeem exceſſive in their careſſes to the miniſters of thoſe countries they intend to invade; but their preparations for arming are made with ſo much noiſe, that an ordinary jealouſy is ſoon awakened thereby to oppoſe them, in caſe of an attack: They ſeldom or never care to have war at the ſame time at both the extremities of the empire, and therefore they are mighty ſolicitous to ſecure a peace with *Chriſtendom*, when they intend a war againſt *Perſia*; and as much as is poſſible, they avoid quarrelling with two *Chriſtian* princes at once; being uſually in league either with *Poland* or *Muſcovy*, when they attack *Hungary*, and ſo on the contrary; dreading nothing more than an union of *Chriſtian* princes who border upon them, leaſt it ſhould prove fatal to their empire, and quickly put a period to their greatneſs; for hereby they would be put to the neceſſity of making a defenſive war to their great loſs and diſadvantage; and at laſt either be forced to beg a peace of the *Chriſtians*, or run the hazard of loſing all by a further proſecution of the war; this they are very ſenſible of; and therefore as they take all occaſions to promote quarrels and diſſentions in *Hungary* and *Tranſylvania*, ſo they greatly rejoice when the princes of *Chriſtendom* are at war with each other; this is their great time of advantage, and they know it is their intereſt to improve it, tho' the bad circumſtances of their affairs do not always allow them: During the civil wars of *Germany*, the Baſhaws and other commanders of the army, were very importunate with the Grand Seignior to make a war on that ſide, and to enlarge his conqueſts as far as *Vienna*, no conjuncture having been ever ſo favourable to conſummate ſuch a deſign, in which *Soliman* ſo unhappily miſcarried; they promiſed him an eaſy victory, aſſuring him that the animoſities of the princes of the empire were ſo heightened, that there was no room left for a reconciliation; that it was but to go at the head of an army to take poſſeſſion; and that *Auſtria* would ſurrender upon the firſt news of his march: The emperor was not then to be moved by theſe inſinuations and plauſible diſcourſes, and being continually urged, he as often refuſed: One day when they came to renew their advice about the *German* war, he having given orders before, that ſeveral dogs ſhould be kept for ſome days without meat, commanded that they ſhould be brought out, after having been almoſt ſtarved, and ordered meat to be thrown amongſt them, upon which they ſnarled and bit each other; amidſt their noiſe and fighting, he cauſed a bear to be let looſe; the dogs forgeting their meat, and their animoſities, ruſhed unanimouſly upon the bear, and at laſt killed him;

this diverſion the emperor gave his Baſhaws, and left them to make the application.

A certain prophecy, of no ſmall authority, runs in the minds of all the people, and has gained great credit amongſt them, *viz.* that their empire will be deſtroyed by a northern nation with white and yellowiſh hair; the interpretation is as various as their fancies; ſome fix this character on the *Muſcovites*; and the poor *Greeks* flatter themſelves with the fond hopes, that they are to be the deliverers of their nation, and to reſcue them from the *Turkiſh* ſlavery; chiefly becauſe they are of their communion, and owe their converſion to the *Chriſtian* faith to the piety and zeal of the *Grecian* biſhops: Others look upon the *Swedes* as the perſons deſcribed in the prophecy, and whom they are moſt to fear; and this fancy may be owing to the great opinion they have of the valour and courage of that warlike nation: The great victories of the *Swedes* in *Germany* under *Guſtavus Adolphus* were loudly proclaimed at *Conſtantinople*, as if there were no withſtanding the ſhock and fury of their arms; and their continued ſucceſſes confirmed the *Turks* in their firſt belief, and their fears and jealouſies were afterwards augmented, when *Charles Guſtavus*, a prince of as heroic a courage, and as great abilities in the art and management of war as the juſtly admired *Guſtavus*, entred *Poland* with his army, and carried all before him; ſeized on *Warſaw*, and drove *Caſimire* out of his kingdom, and had almoſt made an entire and abſolute conqueſt, a few places only holding out: This alarmed the Grand Seignior and Baſhaws of the Porte, as if the prophecy were then about to be fulfilled, who were not fond of ſuch troubleſome neighbours, that might puſh on their conqueſts, and joining with the *Coſſacks*, advance their arms further, and make their country the ſeat of war, which might draw after it fatal conſequences; to prevent which, couriers were diſpatched from *Conſtantinople* to *Ragotski* prince of *Tranſylvania*, then in concert with the *Swedes*, to command him to retire with his army out of *Poland*, as he valued the peace and quiet of his own country, and the friendſhip of the Grand Seignior, whoſe tributary he was, and by whoſe favour he had gained that principality: And the *Crim-Tartars*, the ſworn enemies of the *Poles*, who at that time diſtreſſed them, were wrought upon by the ſame motives and reaſons of ſtate, to clap up a peace with them; that being freed from theſe diſtractions, they might unite their forces the better together, and make head againſt the *Swedes*.

The ambaſſadors of *Chriſtian* princes, when admitted by the Grand Seignior to an audience, their preſents being then of courſe made, which are looked upon as due; not to ſay as an homage, are diſmiſſed in few words, and referred by him to his *Wakil*, or deputy, as he uſually ſtiles the chief vizir; and a ſmall number of their retinue only is permitted the honour of kiſſing his veſt, and then rudely enough diſmiſſed.

The Grand Seigniors keep up the ſtate of the old *Aſiatic* princes; they do not expoſe themſelves often to the view of the people, unleſs when they ride in triumph, or upon ſome ſuch ſolemn occaſion; when they go to the moſques, or divert themſelves in the fields, either in riding or hunting, they do not love to be ſtared upon or approached; it is highly criminal to pry into their ſports, ſuch an inſolent curioſity being often puniſhed with death: The ſtory of *Morad* III. is famous, who baiting a bear in the old palace with a maſtiff, and eſpying three fellows upon the tower of *Bajazet*'s moſque, who had placed themſelves there to ſee the diverſion, commanded their heads to be ſtruck off immediately, and to be brought before him, which was done accordingly; inſtances of ſuch capricio's are frequent in the *Turkiſh* hiſtory, and the following happened during Dr. *Smith*'s ſtay at *Conſtantinople:* Upon the return of vizir *Achmet* from *Candia*, after the ſurrendry of that city, and a happy period put to that tedious and bloody war; he acquainting the emperor, then at *Adrianople*, with the hiſtory of that famous ſiege at large, made ſuch terrible repreſentations of their and the *Venetians* mining and countermining each other, that the emperor was reſolved out of curioſity to ſee the experiment made of a thing that ſeemed to him almoſt incredible; a work was ſoon raiſed and undermined, and above thirty murderers and robbers upon the highway, and ſuch like criminals were put into it, as it were to defend it; the Grand Seignior ſtood upon an eminence at ſome conſiderable diſtance, expecting the iſſue; upon a ſignal given, the mine was ſprung, and the fort demoliſhed, and the poor wretches torn to pieces, to his great ſatisfaction and amazement.

The moon is the auſpicious planet of the *Turks*; according to whoſe courſe they celebrate their feſtivals; they begin their months from her firſt appearance, at which time they chuſe, unleſs a delay ſhould cauſe a greater prejudice and inconvenience, to begin their great actions: The creſcent is the enſign of the empire, which they paint in their banners, and place upon the ſpires of their moſques: Next to the day of the appearing moon, they pitch upon friday to fight, to begin a journey, and eſpecially their pilgrimage to *Mecca*, or to do any thing of great conſequence, as very lucky and fortunate.

The Uſe of the Inteſtinum Cæcum; *by Dr.* M. Liſter. Phil. Tranſ. N° 155. p. 455.

THE uſe of the *Inteſtinum Cæcum* is to be ſubſervient to the *Colon* and *Rectum*; which is manifeſt in ſuch animals, where nature intends a certain and determinate figure to the excrements: By determinate figure Dr. *Liſter* underſtands; 1. The excrements divided into many ſmall parts of a like ſhape; ſuch as ſheep, deer, conies, hares, rats, mice, horſes, caterpillars, ſome ſnails, &c. do naturally void. 2. In a greater latitude, he oppoſes figured excrements to liquid, as *Celſus* does; thus the dung of pigeons and geeſe, men, cats, &c. may be ſaid to be figured; now the *Cæcum* in his opinion is ſubſervient in ſome meaſure to the figuration of both, but moſt manifeſt in the firſt kind; his meaning is, that probably the uſe of the *Cæcum* is to retain the excrements, till they are ſufficiently baked, hardened, or of a due conſiſtence, to receive the figure to be given it from the *Colon* and *Rectum*; this uſe of the *Cæcum* ſeems to be much more manifeſt in ſuch animals as have figured excrements of the firſt kind; in rats for inſtance, whoſe excrements are conſtantly alike figured, the *Cæcum* is very large, more capacious than the ſtomach itſelf; but its uſe in receiving the excrements, or exhauſted chyle, is not more apparent, from its large capacity, than that other of farther drawing and tempering them to a ſtiffneſs, for the ſervice of the *Colon*, from the admirable contrivance and ſtructure of this latter gut, which is a phænomenon that deſerves further conſideration; it is to be noted, that immediately under the valve of that gut, in this animal, there are certain ſpiral fibres, which make a kind of ſcrew; now it ſeems, that the excrements after they are brought to a due conſiſtence by their ſtay in the *Cæcum*, and being carried out thence into the ſpiral foldings, or ſcrew of the *Colon*, cannot deſcend in a perpendicular, as formerly in the ſmall guts, but ſtill gently glide, and that very leiſurely by the winding of the ſcrew, whence ariſes the figure; and it is probable, that if the *Cæcum* of a rat, or any of the firſt kind of animals mentioned was tied up, the animals would unavoidably fall into a diarchoea.

Foſſile Shells *in* Kent; *by Dr.* Griffin Hatley. Phil. Tranſ. N° 155. p. 463.

AT *Hunton*, five miles from *Maidſtone* in *Kent*, and about a quarter of a mile from the river *Medway*, after the coping of a piece of ground was taken off, which was of a clay about three foot deep, they came to a very good blue marle, which was 3 ½ foot deeper; and then there appeared a hard floor or pavement compoſed of ſhells, or ſhell-like ſtones, crouded cloſely together, whoſe interſtices were filled up with the ſame marle; this layer, which run as the veins of flints do in chalky earth, was about an inch deep, and ſeveral yards over; and under this layer there was marle again: The ſtones were of the ſpecies called *Conchites*, and reſembled ſea-fiſh of the teſtaceous kind; moſt of them were turbinated or wreathed, the reſt were of the bivalvular ſort, tho' none of them was found with cloſed valves, but only ſingle: The bigneſs of the turbinated is from a vetch to a hazel-nut, they are filled with a ſtony earth, like the marle, and are of that colour, till you have waſhed and rubbed them, and then they appear of the colour of bezoar, and of the ſame politure; after boiling in water, they are whitiſh, and leave a chalkineſs upon the fingers, which when rubbed off, gives a view of very fine black *Striæ*, thick ſet on the outſide: Theſe wreathed ſtones are all perfectly formed, they differ not in figure from each other, only ſome have their ſides a little depreſſed; there adhered to a few of them a ſmall proportion of a glittering mineral like iron; in vinegar they make a ſtrong efferveſcence: The bivalvular are moſt of them no bigger than a kidney-bean, ſome leſſer; others as broad as the largeſt ſort of beans; but the valve is much thinner than any of that kind, which are the *Exuviæ* of an animal; the gibbous part of the valve is ſmooth, and of the ſame colour with that of the turbinated; in a few there are ſome oblong lines bent circularly to the joining of the valve: Many of the bivalvular ſort ſeem to be *in fieri*, not as to their ſhape; but as to their hardneſs and thickneſs, there being in ſome only the *Stamina* or rudiments, and in others the ſeveral ſteps and progreſſes towards a perfect figuration; which ſeems to be an unanſwerable argument againſt their having been the ſpoils of animals: Some of theſe appeared in the inner ſide white, and it came off on the fingers like chalk, and ſeemed as if a depreſſion had been firſt made in the bed of the ſhape of a valve, and then the convex ſide rubbed with chalk or painted white;

white: Thoſe pieces of this odd concretion, after the marle in the interſtices is grown hard, appear much like that ſort of coarſe marble-ſtone, which is dug about *Pluckley* in the wilds of *Kent*; which ſeems to be a coagmentation of ſuch ſhell-like ſtones, after the marle betwixt them hath acquired a firmneſs and hardneſs; with this ſtone they make their cauſeways in that part of the country, and they are apt to be worn into little cavities or holes, where they have lain long expoſed to the air; the rains, in length of time, waſhing away the portions of marle, which is leſs hard, from between the interſtices of thoſe ſhell-like ſtones; and the Dr. was much confirmed in this opinion by a piece of marble, inlaid, as it were, with ſuch ſtones, which was dug out of a marle-pit: The imperfect, as well as compleat formation of ſome of the bivalvular kind, (the valves being only found ſingle) are no light arguments for their being ſtones: Perhaps the ſalts of plants or animal bodies, waſhed down with rains, and lodged under ground, may be there diſpoſed into ſuch like figures, as well as above it.

The Doctrine of Sounds; *by* Narciſſus Biſhop *of* Ferns *and* Leighlin. Phil. Tranſ. N° 156. p. 472.

THERE is no better way of explaining the uſefulneſs of this theory of ſounds, than by making a compariſon between the faculty of ſeeing and hearing, as to their improvements; in order to which, it is to be obſerved, that viſion is threefold, direct, refracted and reflected; anſwerable whereunto we have *Opticks*, *Dioptrics* and *Catoptrics*: In like manner hearing may be divided into direct, refracted and reflected, to which correſpond the three parts of the doctrine of *Acouſtics*, which are yet nameleſs, unleſs we call them *Acouſtics*, *Diacouſtics* and *Catacouſtics*, or *Phoncis*, *Diaphoncis* and *Cataphoncis*.

Direct viſion has been improved two ways. 1. As to the object, by the arts of producing, conſerving, imitating and duly applying light and colours. 2. With reſpect to the organ or medium, by making uſe of tubes without glaſſes, or a man's cloſed hand to look thro': So likewiſe direct hearing, partly has and may partly further receive great and notable improvements, both with reſpect to the object and the organ or medium. 1. As to the object of hearing, which is ſound, improvement has and may be made therein, both as to the production, and as to the conveying and propagating of ſounds, which is a kind of conſerving them: As to the production of ſounds; the art of imitating any ſound, whether by ſpeaking, that is pronouncing, any kind of language, or by whiſtling, or by ſinging, or by hollowing or luring, or by imitating with the mouth or otherwiſe the voice of any animal; as of quails, cats and the like; or by repreſenting any ſound produced by the colliſion of ſolid bodies, or after any other manner; all theſe are improvements of direct hearing, and they may be further improved: Beſides, the ſkill of making all ſorts of muſical inſtruments, both ancient and modern, whether wind or ſtringed inſtruments, or of any other ſort, whereof there are many, as drums, bells, the ſiſtrum of the *Egyptians*, or the like, which produce ſounds; the ſkill of making theſe, is an art that has much improved direct hearing; and an harmonious ſound exceeds a ſingle and rude one; which art is yet capable of farther improvement; and it is to be hoped, that, by the rules which may happily be laid down, concerning the nature, propagation and proportion or adapting of ſounds, a way may be found out, both to improve muſical inſtruments already in uſe, and to invent new ones, that will be more ſweet and harmonious than any yet known; beſides, that by the ſame means, inſtruments may be made, that ſhall imitate any ſound in nature, that is not articulate; be it of bird, beaſt, or what thing elſe ſoever: The conveying and propagating, which is a kind of conſerving of ſounds, is much aſſiſted by duly placing the ſonorous body, and alſo by the medium; for if the medium be thin and quieſcent, and the ſounding body placed conveniently, the ſound will be eaſily and regularly propagated and mightily conſerved: The medium muſt be thin and quieſcent; hence in a ſtill evening, or the dead of the night, a ſound is better propagated and to a greater diſtance: The ſonorous body muſt be placed conveniently, *viz.* near a ſmooth wall, either plane or arched, either a cycloid or ellipſis, rather than otherwiſe, tho' a circular, or any arch will do, but not ſo well; hence in a church, the nearer the preacher ſtands to the wall, and which alſo is the beſt poſition for pulpits, the better is he heard, eſpecially by thoſe who ſtand near the wall, tho' at a greater diſtance from the pulpit; thoſe at the remoteſt end of the church, by laying their ears ſomewhat cloſe to the wall, may hear him eaſier than thoſe in the middle: Hence alſo ariſe whiſpering places; for the voice being applied to one end of an arch, eaſily rolls to the other; and indeed were the motion and propagations of ſounds but rightly underſtood, it would be no hard matter to contrive whiſpering-places of infinite variety and uſe; and perhaps there could be no better, or more pleaſant hearing a concert of muſick than at ſuch a place as this; where the ſounds rolling long together before they reach the ear, muſt needs conſolidate and embody in one; which becomes a true compoſition of ſounds, and is the very life and ſoul of concert: If the ſonorous body be placed near water, the ſound will eaſily be conveyed, yet mollified; as appears from a peal of bells near a river, and a great gun ſhot off at ſea; which differ much in the ſtrength, and yet ſoftneſs and continuance or propagation of their ſounds, from the ſame at land; where the ſound is harſher and ſooner dies: In a plane a voice may be heard at a far greater diſtance, than in uneven ground; becauſe the ſonorous air meeting with little or no reſiſtance upon a plane, much leſs upon an arched ſmooth ſurface, eaſily rolls along it, without being hindred in its motion, and conſequently without having its parts disfigured, and put into another kind of motion, than what they had at the firſt production of the ſound, which is the true cauſe of its preſervation or progreſſion; and fails much when the air paſſes over an uneven ſurface, according to the degrees of its inequality; and ſomewhat alſo when it paſſes over the plain ſurface of a hard and reſiſting body: Wherefore the ſmooth top of the water, by reaſon of its yielding to the arched air, and gently riſing again, whereby it quickens the motion of the air over it, and by its yielding preſerves it in its arched cycloidal or elliptical figure, conveys a ſound more entire, and to a greater diſtance, than the plane ſurface of a piece of ground, a wall, or any other ſolid body whatever.

The organ, which is the ear, is helped much by placing it near a wall, eſpecially at one end of an arch, when the ſound is produced at the other; or near the ſurface of the water, or of the earth; and it is incredible, how far a ſound made upon the earth may be heard in a ſtill night, if one lay his ear cloſe to the ground in a large plain: Here *Otacouſtics* lend their aſſiſtance to the ear; which may be ſo contrived, by a right underſtanding the progreſſion of ſounds, which is the principal thing to be known for the due regulating all ſuch kinds of inſtruments, as that the ſound may enter the ear without any refraction.

Refracted viſion ariſes from the different denſity, figure and magnitude of the medium; which is ſomewhat altered by the different incidence of the viſive rays; and ſo it is in refracted hearing, all theſe cauſes concur to its production, and ſome others to be conſidered hereafter: Now, as any object, a man for inſtance, ſeen thro' a thickened air, appears lárger by a refraction than really he is; ſo likewiſe a ſound heard thro' the ſame thickened part of the atmoſphere, will be conſiderably varied, from what it would ſeem to be, if heard thro' a thinner medium; and this the Biſhop calls a refracted ſound: Improvements of refracted viſion have been made, by grinding or blowing glaſſes into a certain figure, and placing them at due focal diſtances; whereby the object may be enabled to emit its rays more vigorouſly, and the viſive faculty impowered the better to receive them; thus, a fine glaſs bubble, filled with clear water, and placed before a burning candle or lamp, does enable it to dart forth its rays to a prodigious length and brightneſs: The viſive faculty is much aſſiſted by ſpectacles and other glaſſes, which are made to help the pur-blind and weak eyes, to ſee at any competent diſtance: By perſpective glaſſes and teleſcopes, which help the eye to ſee objects at a very great diſtance, which otherwiſe would not be diſcernible: By microſcopes, or magniſying glaſſes, which help the eye to ſee near objects, which by reaſon of their ſmallneſs were inviſible before: By polyſcopes or multiplying glaſſes, whereby one thing is repreſented to the eye as many, whether in the ſame or different ſhapes: After the ſame manner, inſtruments may be contrived for aſſiſting both the ſonorous body to emit its ſound more ſtrongly, and the *Acouſtic* faculty to receive and diſcern it more eaſily and diſtinctly; and thus, an inſtrument may be invented, that applied to the mouth, or any ſonorous body, will emit the voice diſtinctly to a prodigious diſtance and degree of loudneſs; for, if the *Stentorophonicon*, which is but a rude and inartificial inſtrument, doth ſuch great feats, what might not be done with one compoſed according to the rules of art, whoſe make ſhould comply with the laws of ſonorous motion, which that does not? There are ſome inſtruments, and more ſuch may be invented to help the ear; as *Otacouſtics*, to help weak ears to hear at a reaſonable diſtance; which would be as great a help to the infirmity of old age, as the invention of ſpectacles, and perhaps greater; foraſmuch as the hearing what is ſpoken is of more daily uſe and concern to ſuch men, than to be able to read books, or to view pictures: A ſort of *Otacouſtics* may be ſo contrived, as to take in ſounds made at a very great diſtance, which otherwiſe would not be heard; and theſe *Otacouſtics*, in ſome reſpects, would be of greater uſe than perſpectives: 1. In time of war, for diſcovering the enemy at a good diſtance, when he marches or lies encamped behind a mountain or wood, or any ſuch ſhelter, which hinder the ſight from reaching very far: 2. At ſea, when in dark hazy weather the air is too thick, or in ſtormy tempeſtuous weather, when the waves riſe too high, for the perſpective to be made uſe of: 3. In dark nights when perſpectives become almoſt inſignificant, and yet at ſuch times, generally ſoldiers take their march, when they would ſurprize their enemies. *Microphones* or *Micracouſticks*, that is magnifying ear-inſtruments, may be contrived in ſuch a manner, as to render the moſt minute ſound in nature diſtinctly audible by magnifying it to an inconceivable loudneſs; by means whereof the different cries and tones of the ſmalleſt animals may be heard: A *Polyphone* or *Polyacouſtic* is an inſtrument, ſo ordered that one ſound may be heard as many, either of the ſame or a different note; inſomuch that whoever, uſes this inſtrument, will at the ſound of a ſingle viol ſeem to hear a whole concert, and all true harmony; by which means this inſtrument has much the advantage of the polyſcope.

Reflected viſion, which is always made with reſpect to the object, hath been improved by the invention of looking glaſſes and poliſhed metals, whether plane, concave or convex, of ſeveral figures, and placed at determinate diſtances: In like manner reflected audition or hearing, which is only made by the oppoſite body, may be improved by contriving ſeveral ſorts of artificial echoes; for in general, any ſound falling directly or obliquely upon any denſe body of a ſmooth ſurface, whether plane or arched, is reflected, or echoes more or leſs; but if the ſound be propagated parallel to the ſurface of the denſe body, there will be no echo; and alſo if the ſurface of the oppoſing body be uneven, the air by reverberation will be put out of its regular motion, and the ſound be thereby broken and extinguiſhed; ſo that tho' in this caſe alſo the air be reflected, yet ſound is not reflected, nor is there any echo; it echoes more or leſs, to ſhew, that when all things are, as is before deſcribed, there is ſtill an echoing, tho' it be not always heard; either becauſe the direct ſound is too weak to be reflected to him that made it; or if it is, yet ſo weak, that without the help of a good *Otacouſtick* it cannot be perceived; or becauſe he ſtands in a wrong place to receive the reflected ſound, which paſſes over his head, under his feet, or to one ſide of him; which therefore may be heard by a man ſtanding in that place, where the reflected ſound will come, providing no interpoſing body do intercept it, but not by him that produced it.

Theſe echoes, like reflected viſion, may be produced ſeveral ways; as, 1. A plane obſtacle reflects the ſound in its due tone and loudneſs; if allowance be made for the proportionable decreaſe of the ſound according to its diſtance. 2. A convex obſtacle repels the ſound inſenſibly ſmaller; but ſomewhat quicker, tho' weaker, than otherwiſe it would be: 3. A concave obſtacle echoes back the ſound inſenſibly louder, ſlower, tho' ſtronger, and alſo inverted; but never according to the order of words; nor does it ſeem poſſible for the art of man to contrive a ſingle echo, that ſhall invert the ſound and repeat backwards; becauſe then the words laſt ſpoken, that is, which do laſt meet with the obſtacle, muſt be repelled firſt, which is impoſſible; for where in the mean time ſhould the firſt words lie concealed? yet in complicated or compound echoes, where many receive from one another, ſuch a thing might be poſſible: From this determinate concavity of theſe reflecting bodies, it happens, that ſome of them from a certain diſtance or poſition, will echo back but one determinate note, and from no other place will they reflect any, becauſe of the undue poſition of the ſounding body; The echoing body, being removed farther off, reflects more of the ſound, than when nearer; and this is the reaſon, why ſome echoes repeat but one ſyllable, ſome one word, and ſome many: Echoing bodies may be ſo contrived and placed, as that reflecting the ſound from the one to the other, either directly and mutually, or obliquely and by ſucceſſion, out of one ſound many echoes will be produced; which, in the firſt caſe, will be all together, and ſomewhat involved or ſwallowed up of each other, and thereby confuſed; in the other they will be diſtinct, ſeparate and ſucceeding each other, as in moſt multiple echoes: Moreover, a multiple echo may be made, by ſo placing the echoing bodies, at unequal diſtances, as to reflect all one way, and not one on the other; by which means a manifold ſucceſſive ſound will be heard; as one clap of the hands like many; one *ha* like a laughter; one ſingle word, like many of the ſame tone and accent; and ſo one viol like many of the ſame kind, imitating each other: Furthermore, echoing bodies may be ſo ordered, that from any one ſound given, they ſhall produce many echoes different both as to their tone and intention; by this means a muſical room may be ſo contrived, that not only one inſtrument, played on therein, ſhall ſeem to be many of the ſame ſort and ſize, but even a concert of ſomewhat different ones, only by placing certain echoing bodies ſo, as that any note played ſhall be returned by them in thirds, fifths and eighths: For improving this noble ſcience the following problems are propoſed.

1. To make the leaſt ſound, by the help of inſtruments, as loud as the greateſt; a whiſper to become as loud as the report of a cannon; by the help of this problem, the moſt minute ſounds in nature may be clearly and diſtinctly heard. 2. To propagate any the leaſt ſound to the greateſt diſtance; by means of this problem, any ſound may be conveyed to any diſtance, and conſequently heard at any diſtance, within a certain, tho' very large ſphere: Beſides by this means a weather-cock may be ſo contrived, as that with an ordinary blaſt of wind, it ſhall cry or whiſtle loud enough to be heard many leagues off; which may be found of ſome uſe, not only for pilots in very tempeſtuous weather, when light houſes are rendred almoſt uſeleſs; but alſo for the meaſuring the ſtrength of winds, if allowance be made for their different moiſture; for the drier any wind is, the louder it will whiſtle, *Cæteris Paribus*; becauſe, beſides the ſtrength and dryneſs of winds or breath, there are a great many other things, that concur to the increaſe of magnifying ſounds, produced by them in an inſtrument expoſed to their violence, or blown into. 3. That a ſound be conveyed from one diſtant place to another, ſo as not to be heard in the middle; by the help of this problem, a man may talk to his friend at a very conſiderable diſtance, ſo that thoſe in the middle ſpace ſhall hear nothing of what paſſes betwixt them.

Obſervations on the Midland Salt-Springs, *&c. by Dr.* Liſter. Phil. Tranſ. N° 156. p. 489.

AT *Northwich* in *Cheſhire*, upon the *Weever*, there are four pits abounding in brine, which manifeſtly ſmell of ſulphur, and with galls become black like ink; here they uſe ſand-pans, which are let down into the corners of the great iron-boilers, before the ſalt ſhoots into grains, which faſten on the ſand; beſides, there are thick ſtone flakes raiſed from the bottom of the ſaid iron boilers once a week: It is to be obſerved that, within half a mile of theſe brine-pits, at *Marberry* a ſalt rock was found in boring for coals with the auger: At *Northwich*, *Middlewich*, as alſo at *Nantwich*, and all along the *Weever*, which are places many miles diſtant, if you ſink on either ſide of the river, you will ſcarce miſs of brine; but yet it is a chance, whether it will be ſtrong enough to boil and turn to account; and for this reaſon their pits ſometimes fail them to their great loſs, by a ſmall freſh ſpring breaking into them, and ſometimes the *Weever* itſelf: At *Nantwich*, there is one large brine-pit, whoſe water ſmells as if corrupted, or like ſulphur, but very ſtrongly after a few days forbearing to draw it; it becomes inky with galls; and yields a white ſand or ſtone, adhering in the manner of thin ſcales to the bottom of the iron-pans, wherein the brine is boiled: The water of *Weſton* brine-pit near *Stafford* ſtinks like rotten eggs; with galls it becomes ſuddenly inky; and a ſmall quantity of it purges and vomits violently; they uſe ſand-pans to catch the white ſand, and there are alſo flakes of ſtone raiſed from the bottom of the great iron boilers: The upper *Wich* or brine-pit at *Droitwich* in *Worceſterſhire* is very neatly kept, and exceedingly drawn, becauſe of the number of propietors, and its ſmallneſs; here the ſalt is boiled in ſmall leaden pans, and there is not the leaſt grain of ſand, which either falls before the graining of the ſalt, or adheres to the bottom of the pans, notwithſtanding the contrary has been aſſerted; and therefore this brine being naturally without ſand, it muſt yield the more wholeſome ſalt: The lower pit at the *Netherwich* in the ſame town has but one propietor, and is therefore leſs drawn, yet it is conſtantly and well wrought; and no ſand is found therein; the water of theſe pits ſtinks like rotten eggs, eſpecially after ſunday's reſt; and if fleſh is pickled therein, it will ſtink in 12 hours; and yet the ſalt boiled from theſe pits, is accounted the very beſt inland ſalt in *England:* The author obſerved, in a ditch over againſt the *Netherwich-Houſe*, the water ſtanding with a white ſcum, as at the ſulphur ſpaws in *Yorkſhire*; and he adds by way of corollary. 1. That all the *Yorkſhire* wells, called ſulphur ſpaws, are no other but ſo many brine-pits, and if they were well drawn and wrought, would be as little offenſive in ſmell. 2. That this ſtone powder is alſo to be found adhering to the iron-pans, where the ſea-water is boiled into ſalt, as it is at *Shields* in the biſhoprick of *Durham*; and it is to be obſerved that this ſand falls to the bottom before the ſalt-grains; and this is alſo the caſe in all other mineral ſalts, whoſe brines upon boiling do ever let go this ſtony matter firſt; the oker falls in powder upon the firſt boiling, but the *Lapis Calcarius* riſes and flakes like wafers, waſers, which yet falls in powder by froſt. 3. This ſtone-powder irrigated with fair water, and kept moiſt, does yield an immature ſalt of an uncommon figure. 4. Notwithſtanding the great affinity between the ſalt of the *Midland* brine-pits, which is common ſalt, and ſea-ſalt; there is a ſpecific difference, which Dr. *Liſter* firſt obſerved, and which makes ſea-water a water of its own kind, and ſhews that none of the productions of incinerated plants are truly a marine ſalt; *viz.* that the angles of cryſtals of common ſalt, boiled from the *Midland* brine-pits, as alſo of *Sal-gemmæ*, or rock-ſalt, which the doctor takes to be one and the ſame, are entire; and ſo are all thoſe lixiviated marine ſalts, ſo called and deſcribed by Dr. *Grew*; but the angles of the cryſtals of genuine ſea-ſalt are ever ſome of them cut off into triangular planes at one of the ſides.

Dr. *Liſter* thinks it probable, that the ſea-water was the only element created at the beginning, before the creation of any animal or vegetable, or the ſun itſelf; but upon the creation of theſe, the freſh water had its riſe accidentally; becauſe it owes its being in great part to the vapours of plants, the breath of animals, and the exhalations raiſed by the ſun: Now that the ſea-water is made freſh by the breath of plants growing in it, he thus demonſtrated; he took a long glaſs body, and filling it pretty full of ſea-water, taken up at *Scarborough*, he put therein common ſea-weed, freſh and new gathered, ſome with the roots naked, and ſome growing out, and adhering to ſtones; the glaſs body being full, he put thereon a head with a beck, and adapted a receiver thereto, without any lute, or cloſing the joints; from theſe plants there daily diſtilled, tho' in a ſmall quantity, a very freſh, ſweet, and potable water, without any empyreuma or unpleaſant taſte, as all thoſe diſtilled by fire neceſſarily have: And this he takes to be the moſt natural, eaſy, and ſafe way of having ſweet water from the ſea; and which may be of great uſe, even to ſupply the neceſſity of ſailors; and he doubts not but there may be found ſome other plants growing in or near the ſea, which would better ſuit the experiment, and yield freſh water in much greater quantities; ſuch as rock-ſampire, the kali kind, or the *Braſſica Marina*, &c.

Amongſt the known ſea-plants, the ſargoſſe, or *Lenticula Marina* is not to be forgotten; this grows in vaſt quantities from 36 to 18 deg. N. L. and elſewhere in the deepeſt ſeas: And Dr. *Liſter* thinks, that from the daily and conſtant breath of that plant the trade or *Tropic* winds do in great part ariſe;

becauſe the matter of that wind, coming from the breath of one only plant, muſt needs make it conſtant and uniform; whereas the great variety of plants and trees on land muſt neceſſarily furniſh a confuſed matter of winds: Again, the *Levant* breezes are briſkeſt about noon; the ſun then quickening the plant moſt, and cauſing it to breath faſter and more vigorouſly: As for the direction of this breeze from eaſt to weſt, it may be owing to the general current of the ſea; for a gentle air will run with the ſtream of rivers: Again, every plant is in ſome meaſure an heliotrope, and bends itſelf and moves after the ſun, and conſequently emits its vapours to that quarter; ſo its direction is in that reſpect alſo in ſome meaſure owing to the courſe of the ſun.

Oil *of* Vitriol *increaſing in Weight*; *by Dr.* Will. Gold. Phil. Tranſ. N° 156. p. 496.

SOME druggiſts have accidently obſerved an increaſe of weight in oil of vitriol expoſed to the air; and the induſtrious chymiſt Mr. *White*, the univerſity-operator at *Oxford*, had a phial of that liquor unſtop'd, and conſtantly running over; but ſince from thence no true eſtimate of the juſt encreaſe could be collected, *Nov.* 4th, 1683, the author expoſed three drachms of oil of vitriol, ſo far deplegmated as to burn or corrode a ſtrong pack-thread, to the air in a marmalade glaſs of three inches diameter, and placed in a nice pair of ſcales, in a room where no fire nor ſun came; its increaſe for ſeven natural days, divided by leſs portions of time, was according to the following table.

Nov. 1683.		*Gain.*	*Space of time.*	*Weather.*	*Wind.*	*Sum of Gain.*	*Natural Day.*
D.	*H.*	ʒ ℈. gr.	*H* 6.	*Moiſt.*		ʒ ℈ gr.	
9	5 *p. m.*	3 0 00					
10	11 *p. m.*	0 0 19		*Moiſt and Windy.*	*Southerly.*		1*ſt.*
	8 *m.*	0 1 12	9				
	11 *m.*	0 0 08	3	*Rai. Mor.*	*N. Weſterly.*	1 0 08	
	5 *p. m.*	0 0 09	6	*Clear.*			
11	11 *p. m.*	0 0 18	6	*Starlight Col. brig.*	*N. W.*	0 2 18	2*d.*
	8 *m.*	0 1 07	9	*Morning. Mild.*			
	11 *m.*	0 0 04	3	*Mild dry*			
	5 *p. m.*	0 0 09	6	*Weather.*			

Nov. 1683.		*Gain.*	*Space of time.*	*Weather.*	*Wind.*	*Sum of Gain.*	*Natural Day.*
12	11 *p. m.*	*fere* 0 10	6	*Mild. dry*	*N. W.*	0 1 19	3*d.*
	8 *m.*	0 0 17	9	*clear Mor.*	*N.*		
	11 *m.*	0 0 05	3	*Froſty.*	*N. more*		
	5 *p. m.*	0 0 07	6	*Overcaſt.*	*W.*		
13	11 *p. m.*	0 0 06	6	*Cloudy,*	*Weſterly.*	0 1 3½	4*th.*
	8 *m.*	0 0 09	9	*Rain.*			
	11 *m.*	0 0 03	3	*Cloudy.*	*S. W.*		
	5 *p. m.*	0 0 05½	6	*Mild.*			
14	11 *p. m.*	0 0 06	6	*cloud. miſ.*	*S. E.*	0 0 18	5*th.*
	8 *m.*	0 0 08	9	*cloud. miſ.*			
	11 *m.*	0 0 02½	3	*Miſty.*	*Souther*		
	5 *p. m.*	0 0 01½	6	*very warm*			
15	11 *p. m.*	0 0 02	6	*cloudy, unuſual. war*	*More S.*	0 0 15	6*th.*
	8 *m.*	0 0 06	9	*Cloudy.*	*S. E.*		
	11 *m.*	0 0 03	3	*Clo. moiſt.*	*More S.*		
	5 *p. m.*	0 0 04	6	*Clear cold.*	*Eaſterl.*		
16	11 *p. m.*	0 0 04½	6	*Dry Starl.* *Cold, Clo.*	*Eaſterl.*	0 0 17	7*th.*
	9 *m.*	0 0 09	10	*but Cold.*			
	11 *m.*	0 0 02	2	*Cl. Wind.*	*S. E.*		
	5 *p. m.*	0 0 02	6	*Clo. Mild.*			

From the 16th, in the ſucceſſive ſpaces of 24 hours, each gained one of the number of grains following; as the 8th natural day gained 13 ½, the next 12, 9, 7, 6, 5, 5, 4 ½, 3, 3, 3, 3, 4, 3 (*December*) 4, 4 ½, 4, 3, 3, &c. ſtill irregularly decreaſing till the liquor was ſaturated: The diary was continued to *Jan.* 4th, 168¾, when the increaſe in 24 hours amounted ſcarce to half a grain; and probably had the weather then been dry, it might have been none at all, or rather the liquor might have loſt weight before it had gained: Hence it is obvious, that the more the liquor was ſaturated, the leſs was its daily increaſe, tho' not gradually leſs by an even deſcent each day; but ſometimes for two or more natural days together, it was exactly the ſame, a day or two after, leſs, and then again more the next day following, according as the liquor ſtood affected by the heat and cold, dryneſs or moiſture of the weather, the different time of the day, and quarter of the wind: Thus, upon the view of the whole diary of almoſt two months, it appeared, that the encreaſe was more in a moiſt, rainy, miſty, and ſnowy ſeaſon, but leſs in a froſty, clear, and dry one; as alſo that it was more in a cold than in a warm air: When the wind was northerly or eaſterly, it gained leſs, *Cæteris Paribus* than when ſoutherly or weſterly, and was leſs in the day, than in the night: The primary cauſe of this phænomenon ſeems to be the moiſture of the air, which our liquor, a potential fire, imbibes as greedily, as actual fire does the *Pabulum* of nitre; yet it muſt be allowed, that all the other circumſtances of ſeaſon, juſt now mentioned, have each their particular influences in diverſifying the quantity of the encreaſe; thus it appears by the table, that heat alters the progreſs of its encreaſe; for on *Nov.* 14th, from 11 *m.* to 11 *p. m.* at which time, eſpecially towards night, a very unuſual and troubleſome heat in the air was complained of; in 12 hours the gain was only 3 ½ grains, whereas in the like ſpace of time preceeding, it was 10 ½ grains, and in that juſt following 9 grains: And this effect muſt be expected from heat, ſince thereby the moiſture might rather be exhaled, or at leaſt ſuſpended, agitated and intimately mixed with the ſubſtance of the air, and conſequently not ſo eaſily arreſted and entangled by the ſurface of the liquor, as when the air is leſs hot; however allowing the effect of this anomalous accident, at a time of the year when leaſt expected, and conſidering that moſt commonly heat keeps even pace with the ſeaſon of the year, depending, as to its temper, for the moſt part on the nearneſs or remoteneſs of the ſun, we may ſafely conclude moiſture to be the chief and only cauſe of the increaſe of weight in oil of vitriol; ſince in dry clear weather it conſtantly increaſes leſs than in moiſt and cloudy; the circumſtance of heat or cold remaining the ſame in both: The air doubtleſs has great variety of different ſubſtances floating therein, ſome particles whereof adhere to this body, and ſome other to that, according as either is peculiarly diſpoſed to receive one ſort rather than another; thus on mortar in the joints of old walls and vaults a peculiar kind of ſalt is formed by corpuſcles attracted from the air; and a deal-board ſhelf, moiſtened only with the liquor of fixt nitre, has acquired cryſtals of a perfect inflammable nitre, by regaining the proper acids from the air; and a phial half filled with oil of tartar *per Deliquium*, has been beſet above the liquor with peculiarly figured cryſtals, and at the bottom with flat cryſtallized plates of ſalt, which, without flame, crackled on a live-coal, and left behind a *Calx*; and it is well known that colcothar of vitriol, reimpregnated by the air, will, by a freſh diſtillation, yield its proper acid as at firſt: But to be more certain in this point, he diſtilled off the new-gained ſubſtance; at firſt, it came over as inſipid as clear water; and urging the fire farther, the drops proved ſour, and the remaining oil in the retort was altogether as corroſive as at firſt; whence we may infer, that what the air afforded was mere water: As to the quantity of the whole encreaſe, it cannot be determined by any general rule, ſince it varies according to the different ſtrength of the oil of vitriol; for it appears by the table, that the more diluted the liquor, the leſs attractive it proved; and that employed in this experiment, which was highly dephlegmated, gave a triple, and more than $\frac{1}{8}$ of its firſt weight, amounting in all from 3 to 9 drams and 30 grains before it came to a ſtand; which proportion of encreaſe was confirmed in leſſer quantities alſo; as 3 grains increaſed to more than 9 grains, ſo one grain gave the weight of ſomething more than 3 grains. But beſides the ſtrength of the liquor, there are other circumſtances; as the ſeaſon of the year, and poſition of the place, which will certainly cauſe ſome alteration; thus our liquor will gain more in winter than ſummer, more in a cellar and a room without ſun, than in a room not ſo qualified: All theſe circumſtances, which relate to the quantity, will alſo influence very much the time of the increaſe; but what makes the moſt peculiar and principal variation in this point, is the proportion of the ſurface to the bulk of the liquor; for the greater or ſmaller the ſurface is, the quicker or ſlower the encreaſe; thus 3 grains dropt and diffuſed to near $\frac{3}{4}$ inch breadth on a piece of glaſs, gained 3 grains in 6 hours; 1 grain in 6 more; 1 $\frac{1}{2}$ grains in 12 hours more; in the next 12 hours it gained $\frac{1}{2}$ grain, and in the laſt 12 hours it gained very little that was obſervable; ſo that in leſs than 48 hours, having more than triple its weight, it was for ſome time fully ſaturated, till rainy weather added ſomething more: But to diſcover more nicely what influence the proportion of ſurface has in promoting or retarding the encreaſe of weight, Mr. *Gold* expoſed in the ſame room, and to the ſame temper of the air, about 3 drams of the ſaid oil of vitriol in an open flat glaſs one inch broad, being only $\frac{1}{3}$ of the diameter of that glaſs uſed at firſt with the like quantity; the reſult was, that whereas the other ſurface of 3 inches diameter gained, as in the table, near 19 grains the firſt 6 hours, this leſs ſurface gained a very little more than 2 grains, in the ſame ſpace of time: Now ſince the areas of circles are to each other as the ſquares of their reſpective diameters; as 1, the ſquare of the leſs, is to 9, the ſquare of the diameter of the greater glaſs, ſo was the weight of a little more than 2 grains gained in the narroweſt glaſs, to near 19 grains gained in the broader; wherefore the time of encreaſing bears, as near as can be expected, an exact proportion to the ſurface of the liquor expoſed, and the liquor in the leſſer glaſs having but $\frac{1}{9}$ part of the ſurface of the greater, could not be ſaturated under 9 times as many days as the greater.

By the oil of vitriol, the moiſture and dryneſs of the air may be eſtimated; for when it is ſaturated in the moiſteſt weather, it afterwards retains or loſes its acquired weight as the air proves more or leſs moiſt; thus the one grain abovementioned, after its full encreaſe, often varied its equilibrium a little; *viz.* in dry weather, the weights, in moiſt, the liquor did conſtantly preponderate, and that ſo ſenſibly that the tongue of the balance 1 $\frac{1}{2}$ inch long deſcribed an arch of variation to $\frac{1}{3}$ of an inch compaſs, even with that little quantity of liquor; ſo that if more liquor expanded under a large ſurface be uſed, the minuteſt alteration of weather muſt needs more conſiderably affect it, and a bare pair of ſcales will afford a hygroſcope as nice perhaps as any yet known: This balance may be contrived two ways; either ſuch whoſe centre pin ſhould be in the middle of the beam, with a very ſlender tapering tongue, of a foot, or a foot and a half long, pointing to the diviſions on a broad arched plate, fixed above in the cheeks; or elſe the ſcale with the liquor may be hung to a point of the beam very near the pin, and the other extremity made ſo long, as to deſcribe a large arch on a board placed conveniently for that purpoſe; the ſcale in either may be a concave glaſs of four or five inches diameter: Laſtly, on the diviſion of the arches ſhould be inſcribed the different temperature of the air ſhewn by the liquor: And it is probable that oil of ſulphur *per Campanam*, as alſo oil of tartar *per Deliquium*, and the liquor of fixt nitre, &c. may ſucceed as well: A hygroſcope may be made of a viol-ſtring running upon pullies, and ſuſpending a bullet, fixed to the ſhorter end of an index, whoſe other extremity is ſo long, as to deſcribe a long arch, by the falling and riſing of the bullet, upon the ſtretching and ſhrinking of the ſtring; which would be more nice, if the index was faſtened to the centre of the laſt pulley.

The Cauſe of Earthquakes *and* Vulcano's; *by Dr.* Liſter. Phil. Tranſ. N° 157. p. 512.

THE breath of the *Pyrites* is ſulphur, and it naturally takes fire of itſelf; again, the material cauſe of thunder, lightning and earthquakes, is one and the ſame; *viz.* the inflammable breath of the *Pyrites*; the difference is, that one is fired in the air, the other under ground; for what is burnt with lightning ſmells of brimſtone; and in earthquakes the ſulphureous ſtench of waters is perceived before earthquakes, and of the air itſelf after them: They alſo agree in the manner of their noiſe; the one rolling and rattling thro' the air, and the other fired under ground in like manner moves with a deſultory noiſe: That the earth is more or leſs hollow, is made probable, by what is found every where in the mountains, *viz.* natural cavities or chambers, which the miners of the north call *Self-opens*; theſe they frequently meet with, ſome vaſtly great, and others leſs, running in ſmall ſinus's: Many of them open to day-light, as *Poole*'s-*hole*, or *Okey-hole*, *&c.* Again the great and ſmall ſtreams, which ariſe from under mountains, do evidence their hollowneſs; that theſe ſubterraneous cavities are at certain times and at certain ſeaſons full of inflammable vapours, the damps in mines ſufficiently teſtify; and that the *Pyrites* alone of all known minerals yields this inflammable vapour, is highly probable for the following reaſons: 1. Becauſe no mineral or ore whatſoever is ſulphureous, but as it is wholly, or in part, a *Pyrites*; and many of the *Engliſh* foſſils, which hold brimſtone are alſo found to contain iron. 2. Becauſe there is but one ſpecies of brimſtone, at leaſt here in *England*; and ſince the *Pyrites* alone naturally yields it; it is but reaſonable that wherever brimſtone is found, tho' in the air, or under ground in vapour, to think that that alſo proceeds from it: The *Sulphur Vivum* or natural brimſtone, which is found in and about burning mountains, is certainly the effects of ſublimation, and thoſe great quantities of it ſaid to be found about the ſkirts of volcano's, is only an argument of the long duration, and vehemency of thoſe fires; and tho' *Sulphur Vivum* or rough brimſtone, as they call it, from *Hecla* and *Italy* be opaque, and agree not with the tranſparent and amber-like *Sulphur Vivum* of the ancients; yet it does not follow, that that alſo was not produced by ſublimation; no more than that the *Sallactites*, or water-wrought ſtone, is not ſo made, becauſe ſome of it is opake and ſome cryſtalline: But poſſibly the *Pyrites*

rites of the vulcano's may be more ſulphureous than ours; and it is plain that ſome of ours in *England* are very lean, and hold but little ſulphur, others again a great deal; and this may be one reaſon, why *England* is ſo little troubled with earthquakes, and *Italy* and almoſt all the *Mediterranean* coaſts, ſo very much: Another reaſon is the paucity of *Pyrites* in *England*; beſides the ſubterraneous cavities are ſmall and few, compared to the vaſt vaults in thoſe parts of the world; which is evident from the ſudden diſappearance of whole mountains and iſlands: There are indeed other inflammable minerals beſides the *Pyrites*; but by the providence of God, not to be found in *England*, nor in any quantity in any part of the world, and they are very poiſonous, as orpiments; and they are all ſpecifically diſtinct from brimſtone, which no ore but iron yields, as orpiments are all from gold ore; and by the bye, ſome authors have aſſigned this as a good reaſon againſt any medicine, that ſhall be made from gold (however fond we may be of an *Aurum Potabile*) as having naturally a deleterious quality: It may be objected that no body is kindled by itſelf; but it ſeems to be apparently otherwiſe; for vegetables will heat and take fire of themſelves, as in the frequent inſtance of wet hay; and animals are naturally on fire, and men do alſo ſufficiently demonſtrate it, when in a fever; and amongſt minerals, the *Pyrites*, both in groſs and in vapour, is actually fired of its own accord; and damps naturally take fire of themſelves: Again, the vulcano's, all over the world, argue as much; for it is very probable that they are mountains conſiſting in a great meaſure of *Pyrites*, as appears by the quantities of ſulphur thence ſublimed, and the application of the load-ſtone to the ejected cinders.

The Effect of Lightning *on the Compaſs of a Ship.* Phil. Tranſ. N° 157. p. 520.

JULY 24th, 1681, the ſhip called the *Albemarle*, being a hundred leagues from cape *Cod* in latitude 48°, about three o'clock in the afternoon met with a thunder-ſtorm; the lightning burnt the main-top-ſail, ſplit the main-cap in pieces, rent the maſt quite thro'; and there was in particular one dreadful clap of thunder, with which ſomething fell from the clouds upon the ſtern of the boat, which broke into ſeveral ſmall pieces, and ſplit one of the pumps, the other pump being alſo much damaged; it was a bituminous matter, and much of the ſmell of fired gun-powder; it continued burning in the ſtern of the boat, and it could not be extinguiſhed, till all the matter was conſumed: When night came on, they perceived by the ſtars that their compaſſes were changed; the north point of the compaſs in the binacle was turned clear ſouth; there were two other compaſſes unhung in the locker in the cabbin, in one of which the north point ſtood ſouth, like that in the binacle; as for the other, the north point ſtood weſt; ſo that they ſailed a thouſand leagues by a needle, whoſe polarity was quite changed; the glaſs of the compaſs, whoſe needle the lightning cauſed to point weſtward, being broken after it was brought to *New-England*, by the air's coming to it, it wholly loſt its virtue.

The Production of Stones *in Animals; by Dr.* Fred. Slare. Phil. Tranſ. N° 157. p. 523.

IT is generally obſerved by thoſe that have been ſubject to the ſtone in the bladder, that pains in the kidneys were the antecedents, which intimate the foundation to have been firſt laid there; the manner of its growth in the bladder is obvious; the urine, by ſome called *Lotium*, being too highly ſated or impregnated with a ponderous matter, precipitates the ſame at certain times on the baſis and internal ſurface of the bladder; but that the urine only at ſome intervals is diſpoſed to let fall this matter, ſeems probable from this obſervation, *viz.* that the concrete conſiſts of ſeveral ſpherical ſurfaces, or round incruſtations, which, like ſo many diſtinct ſhells, may be ſeparated from each other; beſides, theſe incruſtations are obſerved to be very unequal, ſome much thicker than others; an argument that the urine continued much longer diſpoſed to let fall this calculous matter at one time than at another; or elſe that it abounded more at one time than at another in this ponderous precipitate, and ſo overlaid it with a thicker cruſt in a ſhorter time: If we examine the cauſes, that have been aſſigned to the production of this concrete; heat in the kidneys cannot be allowed a probable efficient cauſe; a much more intenſe heat than is poſſible to be found here, being neceſſary to make bricks, or bake ſand and earth into ſtone: Nor is it neceſſary to derive the material cauſe from ſuch a ſlimy, ropy, or mucilaginous diſpoſition of the humours that may perhaps coagulate and harden into a ſtone; ſuch a viſcous urine being leſs apt to precipitate this gritty matter than thinner and more limpid urine; for where the urine has often been found ſo ropy and ſtringy, as upon the application of a ſtick to draw out into threads, yet no ſymptoms of the ſtone have ever been diſcovered either in the kidneys or bladder of ſuch perſons: Nor is it probable, that an acid meeting with an alcali conſtitutes ſo firm and ſolid a concrete, it not ſeeming reaſonable that an acid ſhould make this connection, ſince nothing but acids will cauſe the leaſt ſolution: We may alſo except againſt the experiment of coagulation, upon the mixtures of highly rectified ſpirit of urine and wine, which, if warily managed, will make a *Coagulum* with ſuch expedition, as ſeems very ſtrange and ſurpriſing; and yet this concretion will be eaſily diſſolved by water; in like manner, if either of the ſpirits abound much in phlegm, there will enſue no coagulation; but the humours of the human body contain too much water to admit ſuch an effect, even in conſtitutions that have accuſtomed themſelves to very highly rectified ſpirits; beſides, horſes, dogs, and other animals, that drink no wine, are not free from this gritty cementation; and upon diſtillation, this matter was never obſerved to afford one drop of vinous ſpirits: We may alſo queſtion the hypotheſis of the production of the ſtone by petrefaction; ſtones are ſuch fixed bodies that they yield nothing upon diſtillation, unleſs a ſmall quantity of inſipid phlegm chance to riſe; nor will they exhale very much in an open fire; whereas we may volatilize ſix parts of eight of our calculous matter, and obtain ſalts and oils.

The chymiſts deſcribe the concretions of the body, and particularly this morbid one, by calling them tartareous; who conclude they have ſufficiently accounted for the nature of a body, if they can but call it *Tartar*, which muſt be acknowledged to conſiſt of acid and fixt ſalts, called alcalizate, and of ſome *Caput Mortuum*, tho' it be very little in proportion to the other ſalts; but there is little reaſon to darken its nature by that denomination, as appears by the following analyſes; upon diſtilling an ounce of *Calculus Humanus*, recently cut out of a body, it afforded about two drachms of a brown ſpirit, nearer that of hartſhorn than urine; and putting the *Caput Mortuum* upon the coppel, it was reduced to near a drachm, the reſt burning and ſmoaking away: Again, diſtilling in a naked fire a ſtone that weighed two ounces; the vapour came over upon a good ſtrong fire, and ſettled in the form of ſalt, without any liquor, of which only a drachm was preſerved; it appeared very brown, and taſted bitter, as the fœtid oil of hartſhorn and other empyreumatical oils do: In order to try whether it held any fixt ſalt, by boiling and evaporating water from the *Caput Mortuum*, there was none found; the *Caput Mortuum* weighed one

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one ounce and ſix drachms, ſo that it only loſt two drachms in diſtillation, that is, only two drachms came over the helm; proceeding farther, and placing this *Caput Mortuum* upon a teſt in an open fire, where it burnt away to two drachms 44 grains; this was alſo boiled in water, to ſee what ſalt it held; but it ſcarce had any taſte of ſalt: In this trial, an ounce and three drachms of the two ounces evaporated in the open fire, of which there was no account; in order to ſave it, there was placed a tapering chimney or tunnel to receive the ſmoke, as the fire and a pair of bellows raiſed it, which ſo far ſucceeded, that above two drachms of this fuliginous ſubſtance, and ſome drops of a water of a fœtid ſaline taſte were caught: The ſmoke of common fires yields a ſublimate, whoſe chemical principles are no leſs conſiderable than the bodies whence they ariſe; for it was found not only to contain volatile ſalts, oils, and phlegm, but even a ſalt ſo near to common ſea-ſalt, that it ſhot into cubic figures, much like that obtained in an analyſis of human urine; but becauſe it might be objected that that ſalt was probably nothing more than the common culinary ſalt, we conſtantly take in with our food; upon diſtilling the urine of horſes, that were fed with hay and oats, the ſame ſort of ſalt was obtained: Now if we compare this concrete with tartar, we find the one a vegetable ſalt, wholly diſſolvible in water, the other ſo ſtubborn, that ſeveral very corroſive menſtruums, that will eaſily diſſolve iron, copper, ſilver, and almoſt any thing, will not make any impreſſion here; the one affords a little volatile ſalt, which is alcalizate, and no fixt ſalt; the other gives no volatile ſalt, and a very large proportion of fixt; the one affords much more earthy ſubſtance, called *Terra Damnata*, than the hoofs or horns of animals, *&c.* and the other ſcarce leaves any; one abounds with an acid ſalt, which is ſenſible to the palat, and very manifeſt in the ſpirit of tartar; but in the other none could be diſcovered upon the narroweſt ſearch.

The notion of preſuming this calculous matter tartareous, has put men upon uſing medicines to deſtroy tartareous concretions, as well as avoid many things, that ſeem to contain tartar, and yet at the ſame time, may be as inoffenſive as ſome of thoſe medicines that are ſubſtituted, at leaſt, as ſpirit of ſalt, or common ſalt, commended by *Helmont*: In like manner the notion of petrifaction may be no leſs erroneous; there being no agreement or analogies in their natures, whether we conſider them ſynthetically or analytically; if we conſider ſtones in the former view, there is a particular weight or gravity belonging to their bulk, wherein they ſpecifically agree; *viz.* in being twice as heavy as their bulk of water, and about $\frac{1}{3}$ more; and this holds in petrified wood, bone, ſhells, *&c.* but the ſtone of the bladder is much lighter, and ſeveral of them agree in being only as heavy as their bulk of water, and $\frac{1}{4}$ above; this yields to none but the moſt potent acids, and particularly to nitrous ones alone, the other is diſſolved by almoſt any ſlight corroſive: The one affords by analyſis various conſtituent parts; and the other, upon diſtillation, only a drop or two of inſipid phlegm, the reſt remaining fixt.

But this concrete may perhaps owe its origin to a very ſoft and thin fluid, more remotely to the chyle, ſtrained thro' the guts, mediately to the blood itſelf, but immediately to its *Serum*, which ſeems to be its proper vehicle; and we ſhall be leſs ſurpriſed to derive ſuch firm and ſolid productions from fluids, when we conſider that there are particles floating in the blood, always diſpoſed to be converted into griſtles, or to make up the ſolid ſkull, nails, bones, *&c.* and that even the teeth, whoſe texture is very firm, are made and ſupplied from the ſoft fluids of the body: Even ſome of thoſe ſolid parts of the body, may, by a diſeaſe of the blood, be abraded, and abſorbed by the common fluid, and precipitated by their own weight upon the *Pelvis*, or elſe ſtick in the *Tubuli* of the kidneys, and ſo cauſe obſtructions in them, and by degrees extend them to a rupture, or grind them to pieces by a conſtant impulſe of this gritty ſubſtance, which may at laſt convert the greateſt part of the kidneys into this firm concrete: Beſides, without any reſpect had to thoſe ſolid abraſions, the blood itſelf conſiſts of heterogeneous particles, of ſuch various forms, ſizes, and ſhapes, that thoſe deſigned to conſtitute the ſolid parts, may ſuffer ſuch irregular changes in the body, as to render them unfit to paſs the emulgent vein, and ſo to continue their circulation; inſomuch, that the continued impulſe of this matter by the artery, may make very conſiderable aggregates or concretions in the kidneys; and not only ſo, but without reſpect either to vein or artery, the ſerous or watry part of the blood, which above was ſaid to be the vehicle of the ſtone, may have imbibed ſuch heterogeneous, groſs, and ponderous particles, as may, whilſt in motion and agitation thro' the veins and arteries, mix well enough together, but may very eaſily ſeparate, upon the leaſt ſtagnation.

That the nature of this concrete ſeems rather referable to bone, than to any other conſiſtent or fluid part of the body, may

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may be concluded from comparing their chemical products: After clearing the bone of marrow and fat by boiling it in water, upon diſtillation there was obtained about two drachms and a half, from an ounce of bone, of a volatile liquor impregnated with ſalt, different from ſpirit of urine, and nearer that of hartſhorn; the *Caput Mortuum* was found very conſonant as to weight, and no manner of ſalt could be extracted from it; for which reaſon refiners make their coppels of calcined bones, they being forced to dulcify other aſhes, which they call waſhing out the ſalts, before they can make coppels of them: Laſtly, it herein alſo agrees with the *Calculus Humanus*, vulgarly ſo termed, that few acids will diſſolve it, excepting ſuch as are nitrous, nor do theſe work on it very vigorouſly; but they muſt be allowed to differ in their ſpecific gravity, the *Calculus* not having ſo cloſe and compact a texture as the bones have; for bones are found twice as heavy as their bulk of water.

Several ſtones of the bladder and kidneys were diſtilled, and all afforded volatile urinous ſalts, which ferment upon any acids; bones were diſtilled, and found to be of conſonant principles; petrified water affords only freſh and clear water upon diſtillation: *Calculi*, examined hydroſtatically, were found, in proportion to their bulk of water, as 5 to 4; flint, cryſtal, petrified-water, *Welſh* diamonds, petrified wood, are almoſt as heavy again as the calculous matter; and bones are twice as heavy as water: Bones are not eaſily wrought on by common acids, and only by nitrous ones, and that without ebullition: Various unſucceſsful attempts were made to diſſolve the *Calculus* by acid and acrimonious menſtruums; whereof ſome were vegetable, and ſome mineral; as ſpirit of ſalt, of vinegar, of *Venus*, oil of vitriol, *&c.* alſo with alcalizate ſalts, as *Sal fraxini*, which corrodes glaſs, *Lapis infernalis*, but none of them would touch it except the nitrous.

A Polypus *in the Heart*; *by Mr.* W. Gold. Phil. Tranſ. N° 157. p. 537.

A poor labouring man died ſuddenly at *Oxford* in the ſtreets; the vulgar, who alone converſed with him in his illneſs, gave this account of him; that he was of a ſwarthy complexion, afflicted with fits of the falling ſickneſs, with an obſtinate quartan ague of above a year's continuance, a deep black jaundice, an univerſal ill habit of body, and a ſenſe of a deep load and preſſure at his ſtomach; he complained much of extraordinary ſhortneſs of breath, being almoſt conſtantly apprehenſive of choaking; he was continually afflicted with involuntary ſighings, and prodigious palpitations of the heart; and he uſed to ſwoon away very often: Upon opening him, the liver appeared bloodleſs by deep inciſions, and ſtuffed throughout like a bag of ſand with a yellow gritty ſubſtance; the gall-bladder was full of the ſame, but of a darker hue; the ſpleen was very large, and of a very ſoft and looſe texture, not much diſcoloured; the *Omentum* was rotten and waſted; the membrane of the ſtomach was extremely flaccid, and very thin, appearing black and mortified, and upon taking it out about 24 hours after death, tho' tied at both ends very cloſe, it emitted ſuch an intolerable ſour rancid ſcent, that the ſtrongeſt double *Aqua-fortis* could not be ſo offenſive; the lungs were extremely diſtended with a purulent froth; the heart was much ſtretched beyond its natural magnitude, and of a very flat figure; the veins of the whole body were of an unuſual and extraordinary bigneſs, eſpecially the internal jugulars were ſtrained to above ¾ of an inch diameter; polypous concretions were alſo found in the larger veins of the arms, legs, and other parts; but the moſt remarkable was that found in the right ventricle of the heart, and firmly rooted towards its *Apex* or tip, ſo that no ſmall force was required to ſeparate it: The part A, Fig. 1. Plate VIII. by which it was fixed, was nearly an inch and a half in diameter when freſh taken out, it was irregularly rough at the bottom, and inſinuated many roots into the *Lacunæ*, or little cavities of the ventricle, which again were faſtened by leſſer fibres to the inner membrane of the heart; the great branch B, which ran out into the right auricle, was nearly two inches in diameter at the largeſt extremity, and reached no farther than the inſertion of the *Vena Cava*; as for thoſe branches marked G G tending to the arms, how far they extended cannot be affirmed, it not appearing whether they were broken off; but the branches H H H H, *&c.* tending towards the head, could not be extracted without ſome violence, and it is very probable they were broken off at the *Diverticula*, or two round *Sinus*'s, where the jugulars enter the ſcull; for the like concretions were found in the veſſels of the brain, to which probably theſe might be joined; the ſubſtance of the whole was plainly fibrous, reſembling a nerve, and tough whilſt moiſt, but brittle upon drying; its colour was white, and it was cloathed with a thin coat, including (in that part, which filled the right jugular vein) *b b* two black ſpecks of blood, ſuppoſed to be for a long time coagulated there.

It is a queſtion much debated by phyſicians, whether a polypus be produced ſome conſiderable time before, or always immediately after death?

Thoſe who contend for their ſudden generation after death, among other reaſons of leſs moment, inſiſt much on the argument drawn from the tough ſkin ſpreading itſelf in a ſhort time on blood drawn for the cure of pleuriſies, peripneumonies, rheumatiſms, violent head-achs, and in caſes of internal inflammations; and it ſeems a good conſequence, that the ſame coldneſs and want of motion after death may as eaſily produce the ſame in the veſſels; and ſuch concretions have been diſcovered in pleuritical bodies diſſected: But on the other hand it may be urged, that this appearance is not conſtant in all diſſections of bodies ſo affected; whence it may be conjectured, that the outward contact of the air preſſing the ſurface of the emitted blood, or ſome other external cauſe, may contribute to form that ſkin; for why elſe ſhould not the like concretion proceed conſtantly in the blood-veſſels, whence air is excluded, as well as when the blood is expoſed in a porringer; beſides, we find that theſe pituitous bodies ſcarce ever offer themſelves in diſſections of pleuritical perſons, but where the pleuriſy was complicated with ſome other long ſettled indiſpoſition; ſo that the time of their growth cannot be certainly collected from ſuch inſtances; beſides, when they do chance to appear in a ſingle pleuriſy, they float looſe in the maſs of blood without fixing to any part, are of a very lax texture, without any diſtinguiſhable fibres, and like what covers pleuritical blood in a poringer, and do rather reſemble a ſtiffer ſort of jelly or ſize almoſt dried, than any thing of a tough and fibrous conſiſtence, ſuch as is obſerved in a polypus.

Kerkringius aſſerts it in his power to make ſuch concretions at pleaſure by the known experiment of injecting ſpirit of vitriol into a dog's veins; and obſerving the quick coagulation ſo made, infers that ſome peccant acid in the blood, occaſioned by a diſeaſe, may as ſuddenly produce the ſame, when life is gone: To this it may be anſwered, that this artificial polypus is only a kind of grumous and ſtrongly concreted blood, wholly different as to colour, texture, and firmneſs from a true polypus; and it does not follow, that this cauſe muſt always produce its effect in an inſtant, but a longer or ſhorter time will be required, as the cauſe is more or leſs active; yet it is not to be denied, that ſtrange coagulations have ſuddenly happened, and diſſections have often made ſuch diſcoveries in caſes of ſudden death; which are to be looked upon rather as the immediate forerunners of death than the effects of it; ſuch are thoſe concretions, that, on diſſection, have been found in the heart and blood-veſſels of perſons killed by ſudden frights, an apoplexy, a cardiac ſyncope, or a ſuffocating catarrh; in which caſes either the whole maſs of blood is fixed and made unfit for the generation of freſh ſpirits, or elſe the animal ſpirits themſelves are clouded, extinguiſhed, and quite deſtroyed; it is not improbable, that by one or both of thoſe methods the peſtilential effluvia of an infected air, the arſenical exhalation of a damp, and the nitro-ſulphureous ſteam ariſing from burning charcoal, do often act ſuch ſudden and fatal tragedies; for if we reflect on the membranous ſubſtance of the lungs, the infinite number of veſicles they conſiſt of, how that in every aſſignable point theſe veſicles are adorned with capillary blood-veſſels, ſo that the point of a needle every where draws blood; if we calculate the internal concave ſurface of the lungs, ſuppoſed to be unfolded and ſpread out, which muſt needs exceed the external convex one above a hundred times, and conſequently conſider the vaſt ſurface of blood each moment expoſed to the air; and laſtly, if we allow the ingreſs of the air into the blood upon breathing; it is eaſy to imagine how ſuddenly miſchievous, any coagulative poiſonous ſteam may prove, ſince, together with the air, it will be diffuſed thro' all the blood contained in the lungs at the very inſtant of inſpiration, and join itſelf intimately with almoſt each particle of blood, and preſently deſtroy all fluidity, ſtuff the lungs and heart with an immoveable, and almoſt mortified maſs, put a final ſtop to the circulation, and ſo in a moment break the thread of life: Concretions, that have ſuch ſurpriſing effects, muſt be allowed to be ſuddenly produced; yet in the caſe of lingring diſeaſes, they muſt make a ſlower progreſs in their growth, as proceeding from a leſs active cauſe, and by a daily appoſition of new parts ſwell into that ſtrange bulk and ſhape they ſometimes obtain; and the preſent ſubject demonſtrates the thing in ſuch a manner, as to leave no place for doubt; for here the jugulars are ſtretched to thrice their former diameter, which could not be done ſuddenly; the heart, the ſtrongeſt and firmeſt muſcle of the body, obtains a ſhape quite different from the natural; the right auricle and ventricle, notwithſtanding the ſtrength of the fibres of the latter, are ſo prodigiouſly diſtended, that no external force whatever, without breaking it, could effect the like; ſuch hard ſhift did nature make to continue the vital ſtream; till the monſtrous body growing too big, the weakened fibres could ſtretch no more, nor yet regularly contract themſelves any longer; ſo that the heart at laſt, juſt ready to ſink under the burden, is forced to collect its little remaining ſtrength into one briſk effort, and aſſiſted by all the ſpirits of the body, cauſe the poor wretch to expire in an univerſal convulſion.

The diſeaſes wherein almoſt always *Polypi* may be expected, are the apoplexy, phrenſy, falling-ſickneſs, convulſions, aſthma, conſumption, ill-cured pleuriſies, ill-cured and lingring fevers, the plague, venereal diſeaſes, pleuriſies, peripneumonies, green-ſickneſs, varices of the veins, inveterate head-achs, *&c.* The part moſt uſually affected is the right ventricle of the heart, and the venous ſyſtem, where the blood returning from the habit of the body, ſlow in motion, impoveriſhed and diſpirited, more eaſily admits ſuch a concretion; yet the left ventricle and the arterial ſyſtem frequently breed the like; ſuch was that mentioned by *Tulpius*, branching out into the *Aorta* and *Vena Pulmonaris* in a perſon who died of a grievous apoplexy; and ſuch *Wepfer* makes one great cauſe of apoplexies; the *Sinus*'s of the brain do alſo often harbour them; as was found in one that had an obſtinate head-ach, and at laſt died mad; and in another, who once had ſome fits of a phrenzy, and at length died epileptical; in both which caſes, the *Sinus Longitudinalis* was ſtuffed with a *Polypus*, which emitted very tough branches into all the little lateral veſſels; the like alſo *Blaſius* gives an account of in a mad man's brain, who at laſt died convulſed: Upon the ſtreſs of theſe, and many other obſervations of this nature, it is reaſonable to aſſert, that a *Polypus* is ſo far from being a product at the period of a diſeaſe, that it ſeems rather a ſtated ſettled cauſe, as well as an immediate occaſion of the fatal ſymptoms which attend the moſt incurable diſtempers: Thus, if in the heart it grow ſo large as to force a diaſtole beyond the due tenſion of the fibres, it produces a mortal *Syncope*; if ſmaller, and not exceeding the confines of the ventricles, a ſtrong and irregular pulſe ſucceeds, and there muſt be a palpitation of the heart to maintain life; if it ſend branches into the larger pulmonary veſſels, the motion of the blood is retarded, and the breaſt and lungs labour under their load in an aſthma; or, if it reaches the *Capillaries*, a *Peripneumony*, an ulcer, and at laſt a conſumption is at hand; if the concretion begin in the ſmall veſſels of the *Pleura*, then a pleuriſy enſues; if it grow and fix in the larger veſſels of the arms, legs, or the like, painful varices appear; and probably rheumatiſms owe much of their pain to ſome ſuch concretions, begun in the capillary veſſels of the habit of the body; again, when theſe bodies are lodged in the *Sinus* of the brain, if ſmall, the veſſels will only be a little diſtended, and ſo a pain in the head may be the effect; but if larger, the obſtruction increaſes, the brain is inflamed, and a phrenzy enſues; if they happen to be yet bigger, they fill the *Sinus* more, and cauſe the involuntary motions and convulſions of an epilepſy; but laſtly, if the *Sinus* be almoſt totally obſtructed, the blood inſtantly overflows the brain, and an apoplexy enſues.

And thus thoſe diſeaſes have been conſidered, of which a *Polypus* may be rationally thought, at leaſt occaſionally, the next and immediate cauſe; as for others before-mentioned; *viz.* the plague, venereal diſeaſes, lingring fevers and the like; they are not the effects of a *Polypus*, but cauſes, that diſpoſe the blood of ſome perſons to ſuch pituitous concretions: But to diſcover their cauſe more nicely, we may obſerve with *Wepfer*, that perſons, thus afflicted, are never well; they breath with difficulty, have frequent palpitations, unequal pulſes, are dull to all action, ſtupid, luxurious and ſlothful; of a livid, leaden, or ſallow complexion, with a ſaturated red in the hands and face, becauſe there is either very little blood in the *Capillaries* of their ſkin, or at beſt a ſlow circulation; their blood has uſually a thickneſs, and peculiar lentor in it, or a great deal of *Serum*; the latter for want of volatile ſalt to digeſt the chyle into a laudable red; and the former happens, either becauſe the heart deſtitute of ſpirits for its pulſe, cannot duely agitate the maſs, or, as experiments on blood ſeem to prove, by reaſon of the mixture of a preternatural acid: Upon the whole we may conclude, that whatever maintains the fluidity, motion, ſpirit and texture of the blood, promiſes a cure, tho' not of a confirmed *Polypus*, yet of the firſt rudiments thereof; all theſe indications are anſwered by medicines of volatile, briſk, active parts, which deſtroy acids, exalt and ferment the blood, and not only hinder, but alſo diſſolve the firſt beginnings of coagulation; and probably, it is by affecting the blood, and not immediately the nerves, that they do ſuch feats in the diſeaſes abovementioned; laſtly, the effects of bleeding in ſome caſes can never enough be admired; thus *Riverius* tells us of a girl, 12 years old, who, being bled plentifully for a pleuriſy, was cured of her falling ſickneſs, a diſeaſe never without the ſuſpicion of a *Polypus*.

Explication of Fig. 1. Plate VIII. which repreſents the *Polypus*, as it appeared when freſh expanded on a board; A that part which was firmly rooted in the right ventricle of the heart; B the branch terminated in the right auricle, CDDD the part tending towards the lungs; EE the branch running out of the ventricle into the pulmonary artery; *eeeee* the ſeveral leſſer ramifications diſtributed according to the ſeveral diviſions of the pulmonary artery; FFF the branch belonging to the deſcending *Vena Cava*; GG the branches begun in the axillary veins; HHHHH the two branches that run up the internal jugulars to their entrance into the ſcull; *hh* two little black ſpecks of concreted blood contained within the coat of the polypus.

Lough-Neagh *in* Ireland; *by Mr.* Will. Molyneux. Phil. Tranſ. N° 158. p. 552.

IT is generally agreed on by all the inhabitants thereabouts, that *Lough-Neagh* has a petrifying quality, and which it exerts on holly alone; it is alſo aſſerted with ſome probability, that the earth about the *Lough* is endowed with a petrifying virtue; as appeared from the following inſtance; for a little before the rebellion, ſome trees were cut down for building, and among the reſt, a large holly tree, which lying on the banks of the *Lough* all the time of the civil war, the other timber was found overgrown with moſs, but the holly petrified, tho' the water of the *Lough* had never reached it: And perhaps the holly itſelf, that grows on the banks of this *Lough* may be apter to petrify, than that which grows any where elſe, and is brought thither and put into the *Lough*; for certainly if the ground hath that quality, that is very likely to be the effect: That what is called *Lough-neagh* ſtone was once wood, is moſt probable on theſe accounts; 1. It will not ſtir with acids: 2. It will burn and flame, and its ſmoke ſmells like that of wood: 3. When burnt, it betrays the very grain of wood, with the other veſſels belonging to vegetables. 4. There are obſerved various degrees of petrification; as ſome pieces that have plainly loſt the colour of wood, and are become perfectly black, and very hard; others that are neither ſo black nor ſo hard; but Mr. *Molyneux* had one ſent him, which was a parallelopiped, of about four inches long and an inch thick, probably cut into that form whilſt wood; its outward coat was very black, and ſmooth, and merely ſuperficial, for being cleft lengthwiſe thro' the middle, the whole body was diſcovered to be perfectly of the colour and grain of holly; but what was moſt ſurprizing was the diſcovery of the pith which was plainly and perfectly diſtinct in colour and texture, and alſo petrified: What the learned phyſician *Anſelm Boetius* aſſerts in his *Hiſtoria Lapidum & Gemmarum* is certainly falſe; *viz.* that that part of the wood which is buried in the mud will become iron, that part touched by the water become ſtone, and that above the water remain wood; for it was never obſerved that any part of the ſtone did in the leaſt reſemble iron: It is obſerved that this petrifying quality is not equally diffuſed throughout the whole *Lough*, which is about 15 or 16 miles long, and 8 or 9 miles broad every where, but is ſtrongeſt about that part where the *Black Water*, a river ſo called, empties itſelf into this *Lough*, which is about its ſouth-weſt corner; and it is likewiſe ſaid to be ſtronger about its edges than farther in: This ſtone is not magnetical; for it will not ſtir a needle, or ſteel-filings; but tho' it will not apply to the magnet when crude, yet being calcined it applies very briſkly.

A ſtrange Well, *and ſome Antiquities found at* Kirkbythore; *by Mr.* Tho. Machel. Phil. Tranſ. N° 158. p. 555.

A ſtrange well was diſcovered, by the foot of a horſe ſtumbling upon it, in the ſtreet of *Kirkbythore* in *Weſtmoreland*, about ten yards diſtant from the river *Trout-beck*, and as many from the great *Roman* cauſeway, which leads to *Carliſle*; it was covered with a plank of timber, which was ſuppoſed to be oak, about 9 inches thick, in the faſhion of a pot-lid, but decayed and macerated to the colour and conſiſtence of a peat or turf; and above this there was about a yard thick of gravel and pavement; inſtead of walls there were two large wooden veſſels, one upon the other, like hogs-heads, or wine-pipes, with bung-holes about three inches diameter, and the plowings for the heads were plainly to be ſeen; the veſſels were of fir, and above an inch thick; and each of them about 6 foot in depth; at the heads the diameter was 2 foot 8 inches, in the middle 3 foot 5 ½ inches; the wood was ſound, but withal very ſpungy; at the bottom, about 5 yards deep, were planks of wood, laid quadrangular-wiſe, ſupported by a ſtone at each corner, to ſuſtain the fabric, and let in water thro' the gravel and ſand, which lay looſe in the bottom, about a yard deeper: Therein were found ſome old earthen veſſels, with pieces of urns, a piece of a drinking-glaſs, and ſeveral ſandals.

The earthen veſſels were of a very fine metal, ſo to ſpeak, and of a brick colour, and in ſeveral ſhapes; but moſt of them were like a baſon or poſſet-cup; the bowl was ſemi-globular, the foot a ring; ſome were in diameter about 8 inches, and in depth on the inſide more than 3½; and ſome more, ſome leſs; they were for the moſt part very finely imboſſed; but three more eſpecially; *viz.* one with a vine-branch, having a figure in every turning; and firſt a naked man ſtanding only on his left foot, the other a-croſs, and holding his left hand down towards his back, his right towards his belly, with a branch of laurel of three ſprigs, one of which turned up to his face over the crook or bending of his arm; and at his feet was a branch of laurel, and a bloſſom or flower: In the next turning was a vine-leaf, two bloſſoms at bottom, and a-top two peacocks looking behind them: In the next was a victory, as is probable; *viz.* an angel or genius, holding in his right hand a garland of laurel, its arm ſtretched out, and its face turned towards the man; in the left was a ſprig of the ſame tree, with two ſprigs likewiſe at the foot, and flowers or bloſſoms, and a flower in the middle between the garland and one of thoſe ſprigs; and again a vine-leaf and a victory interchangeably, till it ended with a vine-leaf next the figure; upon it were ſome *Gothic* characters of the ſmaller ſort, but dim and obſcure: Another of theſe pots was adorned with circles and ſemicircles; and in one of theſe circles was the figure of a man ſitting on a plinth, or ſquare ſtone; in all the reſt were fluttering Genii: In ſome of the ſemicircles were lions and goats, all ſingle and in a running poſture; and near the bottom were ſtags in courſe and greyhounds purſuing; with an inſcription in *Gothic* characters of the larger ſort, and probably the word *Paulini*; an inſcription in the like characters was to be ſeen at *Burrowbrigg*: The third ſort was ſtill far more beautiful than any of the reſt, being adorned with grey-hounds very well deſigned, and in full purſuit of ſtags, hinds and wild-boars, with the ſame inſcription as on the other: There were other broken inſcriptions, and one on the inſide of the bottom of a plain diſh or platter; but whether it ſtood for *Veſpatian* or *Domitian*, could not be determined.

As to the glaſs, there was but a very ſmall fragment of it, ſo that its figure could hardly be gueſſed at, but it was thought to be a fluted glaſs made like a tunnel or ſpire inverted; it was remarkable that it was about the eighth of an inch in thickneſs.

The urns were of a leaden colour inclining to black; one had been pretty large, two inches thick in the ſide of the pot, the top was in diameter from outſide to outſide, 7 inches, of which the roll was 2 inches, and the mouth 3 inches; the neck was ſtill ſtraighter, and only $\frac{1}{3}$ of an inch thick; and many ſuch were found there, ſome whereof had ears and handles as thick as one's wriſt; and their upper parts were much of the above bigneſs, but thicker and ſtronger; another urn was almoſt entire, tho' a very ſmall one; $8\frac{1}{2}$ inches high, $6\frac{1}{2}$ in diameter, at the mouth almoſt $3\frac{1}{2}$, and in the neck more than $2\frac{1}{2}$ inches; the bottom was nearly as big as the top, excepting the ring; the body was in thickneſs the $\frac{1}{5}$ of an inch, but ſomewhat thicker at top and bottom.

As to the ſandals, ſome were for men, ſome for women, and ſome again for children, all ſhaped by their feet, ſpreading more to the outſide than to the inner; ſome were very large, and ſome crooked; the leather was freſh, but very tender when it came to be ſtretched upon a laſt; each conſiſted of three principal parts; *viz.* an upper leather, or rather heel-piece with two tabs or latchets on each ſide; an inner ſole, $11\frac{1}{2}$ inches long, $3\frac{3}{4}$ broad, conſiſting of 3 or 4 ſoles ſtitched together with leathern thongs, and an outer double-ſole ſtuck full of nails with little round heads, and plated on the inſide, and fixed to the upper leather (threefold in the heel-piece) and ſowed with leather, or rather tacked, which the iron nails helped to defend; theſe were very different from the *Brogues* of *Ireland*, and the *Highlands* of *Scotland*; for the latter have only one ſole, but the former have ſix.

Under-Currents *in the* Downs, *at the* Straights-Mouth, *and in the* Baltic; *by Dr.* Tho. Smith. Phil. Tranſ. N° 158. p. 564.

IN the offing between the north and ſouth *Forelands*, it runs tide and half-tide; that is, it is either ebbing water, or flood upon the ſhore in that part of the *Downs* three hours, (which is, groſsly ſpeaking, the time of half a tide) before it is ſo off at ſea; for the flux and reflux of the ſea is not made exactly, twice in 24 hours, but, as appears by accurate obſervation, it requires an overplus of almoſt 50 minutes: The reaſon of this diverſity of tides is the meeting of the two ſeas in that narrow *Straight*; often when the wind has blown hard at north-eaſt, or at weſt, or weſt and by ſouth, there has happened an alteration of the tides in the *Thames*, which ignorant people have miſtakingly looked upon as a prodigy: And it is a moſt certain obſervation, that where it flows tide and half-tide, tho' the tide of flood run aloft, yet the tide of ebb runs under foot, that is, cloſe by the ground; and ſo at the tide of ebb, it will flow under foot.

There is a vaſt draught of water poured continually out of the *Atlantic* into the *Mediterranean*; the mouth or entrance of which, between *Cape Spartel* or *Sprat*, as the ſeamen call it, and *Cape Trafalgar*, may be nearly ſeven leagues over, the current ſetting ſtrong into it, and not loſing its force, till it run as far as *Malaga*, which is about 20 leagues within the *Straights*; by the benefit of this current, tho' the wind be contrary, if it do not over-blow, ſhips eaſily turn into the *Gut*, as they term the narrow paſſage, which is about 20 miles in length; at the end of which are two towns, *Gibralter* on the coaſt of *Spain*, which gives names to the *Straights*, and *Ceuta* on the *Barbary* ſhore; at which places *Hercules* is ſuppoſed to have erected his pillars: What becomes of this great quantity of water poured in this way, and of that which runs from the *Euxine Sea* into the *Boſphorus* and *Propontis*, and carried at laſt thro' the *Helleſpont* into the *Ægean Sea* or *Archipelago*, is a curious ſpeculation, and has exerciſed the wit and underſtanding of philoſophers and ſailors; for there is no ſenſible riſing of the water all along the *Barbary*-coaſt, even down to *Alexandria*; the land beyond *Tripoli*, and that of *Egypt* lying very low, and ſubject to be eaſily overflowed; they obſerve indeed, that the water riſes 3 feet, or 3 ½ feet in the gulf of *Venice*, and nearly as much all along the *Riviera* of *Genoa*, as far as the river *Arno*; but this rather adds to the wonder: Dr. *Smith*'s conjecture is, that there is an under-current, whereby as great a quantity of water is carried out, as comes flowing in; to confirm which, beſides what was ſaid above about the difference of tides in the offings, and at the ſhore in the *Downs*, which neceſſarily ſuppoſes an under-current; there is an inſtance of the like nature in the *Baltic* ſound, as atteſted by an able ſeaman, who was at the making of the trial: He told that being there in one of the king's frigats, they went with their pinnace into the middle ſtream, and were carried violently by the current; that ſoon after they ſunk a bucket with a large cannon-bullet to a certain depth of water, which gave a check to the boats motion; and ſinking it ſtill lower and lower, the boat was driven a-head to the windward againſt the upper-current; the current aloft, as he added, not being above 4 or 5 fathoms deep; and that the lower the bucket was let fall, they found the under-current the ſtronger.

Two remarkable Caſes relating to Viſion, *viz. A* Nyctalopia *and a* Duplicity *of* Viſion; *communicated by Dr.* William Briggs. Phil. Tranſ. N° 159. p. 559.

A Young man of about 20 years could ſee very well in the day-time, and diſtinguiſh objects at uſual diſtances, as well as any one, and with as much vigour and unweariedneſs; but when once it began to be twilight, he became quite blind, and could not ſee at all; ſo that it was with great difficulty he could direct himſelf abroad, or even at home by the lights of the fire and candle: No diſorder appeared in the viſive organs; no *Vertigo* or diſtemper in the head to interrupt, or any way intercept the ſpirits in their motions; ſpectacles afforded no relief either by the light of the fire or candle; and he was thus affected from the firſt time he was capable of obſervation; and it came without diſtempers; this cloudineſs would come gradually upon him like a miſt, as day-light declined; at all times of the moon he was alike effected; he felt no pain by fire or candle-light; found himſelf no worſe in winter than ſummer, and ſuſtained no harm upon taking cold; he ſweated much at work, but found no difference as to his ſight in thoſe days when he did or did not work hard: This caſe, tho' in a different ſenſe from that of *Hippocrates*, is called by many writers *Nyctalopia*, or *Nocturna Cæcitas*.

The other caſe was of one *Daniel Wright*, about 19 years of age, and of a ſanguine conſtitution; he was ſeized both with a dizzineſs and pain in the upper part of the head, which was owing to exceſſive cold weather; applying himſelf to an ignorant pretender to phyſick, a plaiſter was ordered for his head without any evacuations; the patient upon this grew much worſe, his head-ach became more fixed, and was ſucceeded by convulſive fits, and a tremor upon his legs and arms; upon which, all objects appeared double to him; but in ſome time after a *Gutta Serena* ſeizing on his right eye, the duplicity of viſion then ceaſed and he ſaw all objects ſingle as before.

The Pores *in the Skin*; *by Dr.* Neh. Grew. Phil. Tranſ. N° 159. p. 566.

BY pores, phyſicians mean no more, than certain permeable ſpaces between the parts of a body; and that there are pores in the ſkin, is no more to be queſtioned than whether men do ever ſweat or perſpire; but in the hands and feet they are very remarkable; for if one will with an indifferent glaſs ſurvey the palm of his hand, very well waſhed with a ball, he may perceive innumerable little ridges of equal bigneſs and diſtance, and every where running parallel one with another; and eſpecially upon the ends and firſt joints of the fingers and thumb, upon the top of the ball, and near the root of the thumb, a little above the wriſt; in all which places they are very regularly diſpoſed into ſpherical triangles and ellipſes; upon theſe ridges ſtand the pores, all in even rows, and of that magnitude, as to be viſible to a very good eye without a glaſs; but being viewed with one, every pore looks like a little fountain, and the ſweat may be ſeen to ſtand therein, as clear as rock-water, and as often as it is wiped off, to ſpring up within them again: That which nature intends in the poſition of theſe ridges is, that they may the better ſuit with the uſe and motion of the hand; thoſe of the lower ſide of every triangle to adapt themſelves to the bending in or clutching of the fingers; and thoſe of the other two ſides, and of the ellipſes to the preſſure of the hand or ends of the fingers againſt any body, which require them to yield to the right and left; and the pores are placed upon theſe ridges, and not in the furrows, which lie between them, that ſo their ſtructure may be the ſtronger, and leſs liable to be depraved by compreſſion; whereby only the furrows are dilated or contracted, the ridges conſtantly maintaining themſelves, and conſequently their pores unaltered; and for the ſame reaſon, the pores are alſo very large, that they may ſtill be the better preſerved, tho' the ſkin be never ſo much compreſſed and condenſed, by the conſtant uſe and labour of the hand; and ſo likewiſe thoſe of the feet, notwithſtanding the compreſſion of the ſkin by the weight of the whole body: Theſe pores are a very convenient and open paſſage for the diſcharge of the more noxious and perſpirable parts of the blood; which, by the continual uſe of the hands and feet, are plentifully brought into them; whence it is that many hypochondriacal men and hyſterical women, have almoſt a continual burning in the ſoles of their feet, and the palms of their hands; yet not on the top of their feet, or back of their hands; which being leſs diſpoſed to receive the noxious parts, are therefore unfurniſhed with theſe kinds of pores.

Of the Cuticula *or* Scarf-ſkin; *by M.* Leewenhoeck. Phil. Tranſ. Nº 159. p. 572.

M. *Leewenhoeck* does here correct his former notion of the formation of the ſcales of the ſcarf-ſkin, and by better glaſſes he was ſatisfied that they are not made of the groſſer part of the moiſture which is evaporated out of the body, but are mere ſcales, ſuch as grow upon the external ſkin of a fiſh, and are called fiſh-ſcales: Theſe ſcales lie upon our bodies, juſt as they do upon fiſhes; for the moſt part they are of five ſides; they are very thin, and their breadth exceeds their thickneſs above 25 times; they lie three deep upon the body, every part being covered with three ſcales ſucceſſively, tho' not above $\frac{1}{3}$ of a ſcale diſcover itſelf to the eye, the other $\frac{2}{3}$ parts being hid by the other ſcales: The ſcales of fiſhes alſo appear but in part to the eye; but it is very obſervable, that tho' fiſhes never change their ſcales, yet men often do: Thro' many of the ſcales there run tranſparent lines, and theſe lines are ſometimes ſtuck with round balls, of the bigneſs of a blood-globule: Theſe lines M. *Leewenhoeck* ſuppoſes to be cauſed by the ſweat of the body, bringing with it ſome groſs ſubſtances, which adhere to the ſcales; the globules may either come whole from the body, or elſe be afterwards formed of the matter, which is evaporated: It is eaſy to conceive how a louſe, flea, or other inſect may thruſt its ſting, or ſnout, into the ſkin, for they need not do it thro' the ſcales, but between the plates or mailes: From hence alſo may be gathered, that there are no pores in the cuticle, for the conveying of ſweat, becauſe it may ouſe out from between the ſcales, tho' they ſtick never ſo cloſe together, without ſuppoſing that there are channels made for its paſſage: Let us only reckon how many vacuities a ſcale has, whereby it is nouriſhed; and in the ſpace of $\frac{1}{3}$ of a ſcale there may be 100 ſuch vacuities, thro' which the humours of the body may paſs; and ſuppoſing that 200 ſuch parts of a ſcale may be covered with a ſand; it will follow, that the body may perſpire from 20000 places, which take up no greater ſpace than what a ſand can cover.

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The Bridge *at St.* Eſprit *in* France; *by Dr.* Tancred Robinſon. Phil. Tranſ. N° 160. p. 583.

THIS famous *Roman* bridge is very crooked, bending in ſeveral places, and forming many unequal angles, eſpecially where the ſtream is ſtrongeſt; in which place the angle is moſt unequal and the greateſt; the arches are very wide, and have their feet, or piers, ſecured by two pedeſtals, that encompaſs them; both theſe pedeſtals have their degrees of projectures or juttings out, like ſo many rows of ſtairs or ſteps; the lowermoſt order projecting moſt, the others leſs by degrees; the ſecond or uppermoſt pedeſtal is much leſs than the firſt or lowermoſt, being built a little within its lines of circumference; between the great arches there are windows, or, as it were, ſmall arches, that reach down to the very plane of the ſecond, or uppermoſt pedeſtal, dividing the feet of the great arches: From this deſcription it appears, that the *Romans* have here contrived all poſſible ways gradually to break the mighty force of the *Rhone*, and to render its paſſage eaſy, and inoffenſive to the feet of the great arches; for here are ſeveral paliſadoes and ſluices, ſufficient to defend this wonderful fabrick from all the rudeſt attacks of the torrent; the ſeveral rows of ſtairs projecting from the pedeſtals, which are for the moſt part of a triangular form, and well faced with free ſtone, oppoſe and break the ſtream ſeverally, and not at once, on account of their unequal juttings; and in caſe the flood ſhould ſwell ſo high, as it frequently does, as to cover both the pedeſtals, then the ſmall arches, which divide the feet of the great ones, help to convey the water thro', which otherwiſe might endanger the great arches: Dr. *Liſter* adds the following remark; *viz.* that what ſeems the foot of the arch, is an horizontal arch gradually contracted, every ſtone being of a vaſt length, and wedge-like, and laid level with the water.

The Projection of the Threads *of* Spiders; *and of* Bees *breeding in Caſes made of Leaves*; *by Dr.* Liſter. Phil. Tranſ. N° 160. p. 592.

DR. *Liſter* takes the forking of ſome threads to be merely accidental, and not deſignedly done by the animal; for he obſerved them exceeding ſleek and ſmooth; there is, he owns, a diviſion in the projection of the threads of many ſorts of ſpiders, and eſpecially of thoſe diſtinguiſhed by the name of *Lupi*; which tribe is very numerous, and particularly delights in ſailing, yet this diviſion is very different from forking; theſe *Lupi* will dart a whole *Stamen*, or ſheaf, at once, conſiſting of many filaments; yet all of one length, and divided each from the other, and diſtinct, until ſome accident either ſnap them off, or entangle them; but for the moſt part you may obſerve, that the longer they grow, the more they ſpread, and appear to a diligent obſerver, like the numerous rays in the tail of a comet; their ſwiftneſs in the air is partly owing to their ſudden leap, partly to the length and number of the threads projected, and partly to the poſture and management of their feet, which ſome of them are obſerved to uſe like wings or oars; the ſeveral legs being ſometimes cloſe joined, at other times open, again bent or extended, &c. at the pleaſure of the animal: They cannot be ſtrictly ſaid to fly, ſince they are carried into the air by external force; but they can, in caſe the wind ſuffer them, ſteer their courſe, and perhaps mount and deſcend at pleaſure; and as to their rowing along the air, it is obſervable, that they ever take their flight backwards, that is, with their head looking a contrary way, like a ſculler upon the water; and it is ſcarce credible to what heights they will mount; which yet is preciſely true, and a thing eaſily to be obſerved by one that ſhall fix his eye for ſome time on any part of the heavens, the white webs at a vaſt diſtance appearing diſtinct from the azure ſky; but this is in autumn only, and that in very fair and calm weather.

Dr. *Liſter* alſo obſerved, that bees breed in caſes of leaves, and that they are not very ſcrupulous in their choice of them, but will make uſe even of exotic plants, ſuch as the blue-pipe or ſyringe-tree: The furthermoſt bee, according to Mr. *Willoughby*, makes her way out along the channel thro' all the intermediate cartridges; and as theſe channels run upwards or downwards in the body of the tree, the maggot-bee at the further or upper end of each channel is firſt laid, and it ſhould ſeem, both firſt hatched and perfected; and muſt either wait till the reſt be ſo too, or of neceſſity, by working thro' their caſes, deſtroy them: But Dr. *Liſter* takes it to be otherwiſe; *viz.* that that bee which is neareſt day, tho' laſt laid, is yet the firſt hatched; and he grounds his conjecture upon this, that it is probable, that the eggs in the mother are all fit for laying, or equally ripe and forward at the time the firſt was laid, but they are not therefore all laid at once, till the dam hath provided each of them ſeparately with meat and lodging; and the warmth of her body, or rather the daily encreaſing heat of the ſummer ſeaſon, to which the parent-bee is continually expoſed, whilſt the firſt laid eggs are ſheltered in their deep channels, haſtens their vitality ſo much, that they are hatched worms, and begin to feed, before thoſe firſt laid, and conſequently are firſt perfected into bees.

A monſtrous Child; *by M.* Chr. Krake. Phil. Tranſ. N° 160. p. 599.

FEB. 29th, 1684, at a village called *Heiſagger*, near *Hatterſleben* in *South Jutland*, a ſoldier's wife was delivered of this monſtrous child, Fig. 2. Plate VIII. It was ſuppoſed ſhe had ſeen ſome body wounded or disfigured in the ſame manner, as this child was; on the left leg 1 was to be ſeen an oblong round piece of fleſh of a brown and blue colour, ſomewhat ſharpened at the extremities, which was joined to the calf of the leg 2, and could be moved from 1 to 3; the other piece of fleſh 4, was of the ſame colour, but faſtened to the leg, ſo as not to be diſplaced; on the right foot it had ſix toes; 7 was like a bullet of a piſtol, which hung looſely to the leg; 8 another bullet ſomewhat bigger; the face looked pretty old, as if it had been 30 or 40 years; 5 and 6 at the forehead there were excreſcences like artificial lace, eſpecially when the head was turned to the light of the ſun; it looked fiercely with the left eye, keeping the other cloſe; behind the head there was ſomething like a hood, or other ornament, which women commonly do wear; his arm was of the figure repreſented in the ſcheme, with ſeveral knots or joints; the tail, which in a ſtrange manner grew out of the back part, 9, was ¼ of a *Zealand* ell in length: This monſter, after it had cried out twice or thrice, preſently expired.

The Natron *of* Egypt, *and* Nitrian Water *examined*; *by Dr.* Ch. Leigh. Phil. Tranſ. N° 160. p. 609.

THE natron of *Egypt* is an alcali ſalt, perforated like a ſponge, and of a lixivial taſte; and thus it is deſcribed by *Pliny*, *Mathiolus*, and *Agricola*: Its principles ſeem to be chiefly two; *viz.* a ſal-marine, and an urinous ſalt; that it contains the former ſeems manifeſt from theſe experiments; 1. Becauſe a ſolution of the natron has the ſame taſte that a ſolution of ſal-marine hath. 2. In evaporation, the particles of the natron become incruſtated upon the ſurface of the water, in the ſame manner as the particles of ſea-ſalt. 3. Becauſe the natron is porous, which ſeems to proceed from a ſal-marine; for this, when it cryſtallizes, ſhoots with little cavities. 4. If the natron be mixed with ſalt of tartar, it emits the ſame ſpirit, as ſal-armoniac, when mixt with the ſame ſalt. 5. That it contains a ſea-ſalt, ſeems plain from *Ceſalpinus*: But here it is to be noted, that tho' the *Nitrian* water be of a bluſhy colour, and makes a briſk fermentation with an acid; yet a ſolution of natron looks clear, and will not ferment with an acid: The reaſon why a ſolution of the natron looks clear, tho' the *Nitrian* water, which is but a ſolution of the ſame ſalt, is of a bluſhy colour, may poſſibly be this; that the water of *Latron* receives its redneſs from a red clammy ſubſtance, which ſerves chiefly to cement the two ſalts together; and this the rather, becauſe, after a ſolution of the natron had paſſed thro' a filtre, there ſtuck to it a red clammy matter, and the ſolution was clear; and the reaſon why a ſolution of the natron will not ferment with an acid, ſeems to be this; becauſe that in a perfect diſſolution, its parts being ſeparated from each other by thoſe of the water, their ſtrugglings are too weak to make an effervеſcence with an acid; and this is further confirmed by theſe two experiments; *viz.* if to the ſolution of the natron be poured an acid, whilſt the water looked whitiſh or turbid, the ſalt not being perfectly diſſolved, it made a briſk fermentation; but when the water came to be clear, the ſalt being then perfectly diſſolved, if an acid were poured upon it, it would not ferment; it was likewiſe found that this ſolution, being evaporated to a third part, would ferment again: Its ſecond principle is an urinous ſalt; 1. Becauſe if mixed with ſalt of tartar, it ſmells like ſal-armoniac, when mixed with the ſame ſalt. 2. When it was diſtilled with ſalt of tartar in a retort, it afforded an urinous ſpirit, as penetrating as the ſpirit of ſal-armoniac: It ſeems to receive the ſal-marine, which is a foſſile ſalt, from the earth, but its volatile alcali from the air; M. *de la Chambre* affirms, that three or four days before the *Nile* begins to overflow, there falls a certain dew, which hath a fermenting virtue, and leavens a paſte expoſed to the air; and at the ſame time the nitre-pits grow full of nitre; and many affirm, that tho' 500 die in a day of the plague at *Grand Cairo*, before the beginning of the inundation of the *Nile*, yet the day immediately after, there does not one die; which could not proceed from any other cauſe, than that the air was then impregnated with this volatile alcali; for, at that time the nitre-pits grow full, and this dew falls; about the time the *Nile* began to overflow, certain ſpecimens of it at *Oxford* grew heavier by being expoſed to the air: Here it is to be obſerved, that this alcali is not made ſo by fire, contrary to *Van Helmont*, who would have all alcalies ſo made.

The learned Dr. *Huntington*, who was at *Nitria*, gives this account of its ſeparation from the water in the *Latron*; there is a town in *Egypt* called *Nitria*, which gives name to the *Nitrian* deſart, where is a lake called *Latron*, which takes up an area of ſix or ſeven acres, and is ſituated about 30 miles W. by S. from *Terana*, a town that lies lower down the *Nile* than *Grand Cairo*, and about the ſame diſtance N. W. from the pyramids; from the bottom of this lake, this ſort of nitre, called natron, ariſes to the top, and there the heat of the ſun, condenſes it into this kind of ſubſtance; that all the nitre comes from the bottom to the top Dr. *Leigh* dares not affirm, but he premiſes ſome phænomena it afforded in evaporation, before he gives his conjectures about it: He took an evaporating glaſs, which held about four ounces, and he poured into it two ounces of the *Nitrian* water; this he ſet upon a ſand-furnace, giving it fire by degrees; as ſoon as the water was warm, the particles of the nitre began to ſwim upon its ſurface in ſtraggling and uneven numbers; theſe after a while united, and at laſt there aroſe ſalt ſufficient to cover the whole ſurface of the water; he then took a thin glaſs, and ſcummed off this ice, but he could ſcarce take it all off, before it was ſucceeded by another; and thus the ſalt roſe ſucceſſively in films, as long as there was any water in the glaſs; theſe films had the colour and taſte of the nitre which came from *Nitria*, and like it, it fermented with an acid; and theſe are what *Pliny* called *Flos Salis*, and probably the ſame with what *Herodotus* ſays they made their mummy with; if therefore by the languiſhing heat of a digeſting furnace, the nitrous particles could ſeparate themſelves from the water, and form themſelves into an ice; it may be as probable, that by the greater heat of the ſun, the nitre of *Latron* is ſeparated from the water after the ſame manner; and as in the evaporation of all other mineral waters, when the water is not ſtrong enough to hold up the ſalt, it is generally covered with a thin film; ſo, he ſuppoſes that, in the evaporation of the natron, ſome parts of the water being flown away, the particles of the ſal-marine branch one into another, and ſo incruſtate upon the ſurface of the water: In this hypotheſis he was the more confirmed by the following experiment; he took ſome of the natron, and diſſolved it in water, and ſet it to evaporate; and he found that the ſalt did not incruſtate upon the water, till three parts of the water was evaporated; it did not therefore ſeem probable, that the nitre came all from the bottom to the top, and ſo was condenſed by the heat of the ſun; but that they incruſtrated, when the ſaline particles branched one into another, after the evaporation of ſome of the aqueous parts: The reaſon why its volatile alcali, in evaporation, does not fly quite away, is, becauſe it is held there by the ſal-marine: By the teſtimony of *Hippocrates*, *Galen*, *Mathiolus*, *Dioſcorides*, *Pliny*, and *Agricola*, it appears to have been of great uſe in phyſick; but here it is to be noted, that when they preſcribe nitre, it is not to be underſtood of that which is an ingredient in gun-powder: M. *de Clos* is of the opinion, that moſt of the mineral waters in *France* are impregnated with this ſort of nitre, and that all their efficacy is owing thereto: *Molenbrochius* affirms, a tincture of *Aphronitrum* to be of wonderful efficacy in the ſtone; and *Junken* in his *Medicus* ſays, that the nitre of *Nitria* is of ſo penetrating a ſpirit, that it does not ſuffer either rock or ſtone to be thereabouts: In treating of its uſe in agriculture, Dr. *Leigh* premiſes one phænomenon, which it afforded in evaporation; *viz.* when the ſalts ſpread themſelves over the water in an ice, theſe thin plates would, after a while, be generated, and aſcend in perpendicular lines to the very top of the glaſs; he therefore conjectures, that nitre may be ſaid to fertilize the ground after this manner, its volatile particles being heated by ſome ſubterraneous fire, or elſe by the warmth of the ſun, quickly aſcend in the ſmall tubes of the plant; and ſo, by their elaſticity, carry along with them, or force before them, thoſe particles, which, as they differently unite, conſtitute the different parts of the plant: But this conjecture will become ſomething more probable by an experiment in *Kircher*; where he ſays if you take a wooden tube, and put into it tartar, quick-lime, ſalt and the urine of a wine-drinker, reduced into one maſs, which is to be hardened in the ſun, and afterwards ſet in a cold cellar; by the help of ſaltpetre, from the above-mentioned maſs you will ſee flowers branch out; yea, ſuch is the force of nitre, that, if in a glaſs kept cloſe ſhut, you pour the juices of ſome nitrous herbs on the above maſs, the nitre con-

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contained within it, being pregnant with ſpirit, will force itſelf thro' the very pores of the glaſs: M. *de la Chambre* ſays, that plants grow in *Egypt* in ſuch plenty, that they would choak each other, if they were not hindred by throwing ſand upon the fields; inſomuch that the *Egyptians* muſt take as much pains to leſſen the fatneſs of their ſoil, as other nations to encreaſe it: It is ſaid by *Pliny*, that a company of merchants being thrown upon a ſhore, where no ſtones were to be found, were obliged to take great pieces of *Egyptian* nitre and make walls thereof, on which they hung their boiling kettles; the nitre being heated by the fire mixed with the ſand, and ran into ſeveral ſtreams of glaſs, which afterwards gave the hint of making glaſs: *Pliny* and *Vitruvius* affirm that, by the help of nitre, the true azure is made; and that without it there cannot be a true ſhadow: This nitre is diſtinguiſhed from ſalt-petre: 1. By its fermenting, which it will do with any acid, which ſalt-petre will not do; Dr. *Leigh* found it to ferment with vinegar, which holds not as to ſalt-petre; as the old *Commentators* have obſerved in their comments on *Jeremiah* and the *Proverbs*, which gave occaſion to ſome to alter the word *Nitre* in thoſe texts. 2. It may be diſtinguiſhed from ſalt-petre in its taſte; for natron hath a lixivial taſte, but the other not. 3. By the volatile ſpirit it affords; for from the one comes over a volatile alcali, but from the other a corroſive acid. 4. The natron affords a red clammy inſipid ſubſtance, but the other not; and this clammy ſubſtance ſeems to be, according to Dr. *Leigh*, what *Pliny* calls *Ærugo Salis*. 5. Like ſalt-petre it will not cryſtallize. 6. In the fire it makes no detonation: But in this it reſembles ſalt-petre; as the former, by the flowers of ſulphur, is made into a *Sal Prunellæ*, ſo the latter, if you drop ſpirit of ſulphur upon it, ſhoots into pyramidal cryſtals not diſtinguiſhable by the taſte from *Sal Prunellæ*, tho' its taſte before was lixivial: It may be diſtinguiſhed from *Sal Armoniac*; firſt, by its colour; for the natron is reddiſh, the other not; ſecondly, by the texture of its parts; in *Sal Armoniac* they ſeem cloſe, and firmly knit together, but the natron is ſpongy and perforated; thirdly, if mixed with *Sal Armoniac*, the latter emits the ſame ſpirit, as it does, when mixed with quick-lime: But Dr. *Leigh* is of opinion, that it comes nearer the nature of *Sal Armoniac* than ſalt-petre; firſt becauſe it is compoſed of a ſea-ſalt, and an urinous alcali; ſecondly, like *Sal Armoniac*, when diſſolved in water, it makes it extremely cold, and according to *Franciſeus Hernandez*, it produces the ſame effect, when diſſolved in wine.

An Account of the Porphyry Pillars *in* Egypt; *by Dr.* Rob. Huntington. Phil. Tranſ. N° 161. p. 624.

THERE is no quarry, or rather rock of porphyry in all the lower *Egypt*; for ſo far as the *Nile* over-flows is perfect ſoil: The boundaries of this overflowing are riſing hills of ſand, which are never ten miles from the channel, that Dr. *Huntington* obſerved, generally ſcarce five, and in ſome places but a mile or two, excepting the *Delta* which is covered all over, but the north ſide to the ſea, and a little to the eaſt for ſome miles above *Damiata*; beyond theſe hills is perfect deſart; under theſe ſands is a yielding ſtone, not much harder than chalk, tho' not ſo white, and very eaſily wrought; as at the mummies are deep ſpacious vaults, the ancient repoſitories of the dead; and the like may be alſo ſaid of thoſe cells or ſepulchres which are hewn purely out of the rocky earth three quarters of a mile on the ſouth of *Alexandria*; tho' nearer the ſea there are ſtones of a harder kind, and with which they build; but by their mouldering away, as appears by the ruins of houſes within the walls of the city, it is plain they cannot endure the weather, which is there ſufficiently corroding, the iron, with which once their thick wooden gates were plated being moſtly eaten away, and the deep characters on the ſides of theſe very porphyry pillars being exceedingly defaced; it is true that about *Memphis*, or near the pyramids they have a milder air, and the hieroglyphics cut in theſe ſtones will laſt well enough, till they be removed into a rougher, for then they are found by experience to ſcale: Farther in the country are mountains of harder ſtone; in the *Nitrian*, now the deſart of St. *Macarius*, and not far from the lake *Latron*, where the true nitre incruſtates on the top of the water, there are many, and ſome of them not unlike porphyry; that which neareſt reſembles its colour, tho' not its conſiſtence, is the vein which produces the eagle-ſtone, of which there are many in the *Bahr Batama*, a great ſandy valley; but theſe ſtones are of a different grain from porphyry.

The *Franks* call theſe pillars *Aguglia*'s and the *Engliſh* in particular *Cleopatra*'s needles, but the inhabitants content themſelves with the general name of pillars; they have no baſes or pedeſtals above ground; and if they ever had any, they muſt needs be very deep in the earth; the clearneſs of their grain may perhaps be owing in part to the air which corrodes them, eſpecially on the eaſt and north: The hieroglyphic characters wherewith they are engraven are probably the aboriginal *Egptian* letters, long ſince become obſolete; and they reſemble the *Chineſe* characters, each whereof repreſents a word, or rather an intire ſentence; beſides they ſeem to be written the ſame way, *viz.* from top to bottom.

A Clock *Deſcendent on an inclined Plane; by Mr.* Maurice Wheeler. Phil. Tranſ. N° 161. p. 647.

THE outſide of this clock is a circular body of $3\frac{1}{2}$ inches diameter, conſiſting of two plates, meaſured by the ſame radius, and fixed in a parallel poſition to each other by the hoop *h*, Fig. 3. Plate VIII. whoſe breadth is about an inch; this hoop and the two plates form the caſe of the movement; the anterior plate is inſcribed with a horary circle, whoſe diviſions anſwer the hours of a natural day; the deep ſhades within this circle are intended to repreſent a concave, nearly half an inch in depth, and the prominence *g*, in the middle of this concave, is a hemiſphere of braſs or ſilver, riding looſely on a pin, which lies hid, and is the axis of the movement; the upper half of this hemiſphere is hollow, but the lower filled with lead, and the little winged figure that ſits thereon, does with its exerted finger perform the office of an index; but this being only for ornament, you may ſubſtitute any other index, providing the axis, whereon it is ſupported, move freely in the hole H Fig. 4, and the lower part thereof H L ſo far preponderate H P, as always to keep it pendulous, with its point to the vertical hour.

The manner of its motion, as far as it appears externally, is thus; S E Fig. 3. repreſents a board or ſhelf of a ſtreight and even ſurface, about 6 foot long, and ſo thick as not to be apt to caſt with change of weather, nor grow camber under a ſmall weight; on this the movement is placed, and hereon it performs its courſe, and therefore it is called the ſtage of the movement; and this ſtage is raiſed at the end S, about 10 degrees above the horizon or line of level H E; but the angle of its declivity D E H is variable; the two plates, which form the caſe of the movement, are to ſtand out all round without the hoop *h*, $\frac{1}{8}$ of an inch, and their edges to be ſlightly indented; that while the movement deſcends upon the ſtage, it may only turn, and not ſlide: The movement being placed as high as poſſible near the point S, ſhall move downwards towards E, ſo as to finiſh one entire revolution in 24 hours; and while it does ſo, the diviſions on the horary circle, or dial-plate, ſucceſſively culminating over the point of the index, which is always to keep the ſame poſition, will ſhew the hours of the day and night; for in this movement, contrary to what is uſual in others, the hour is diſcovered by the acceſs of the numbers to the index: Now after repeated revolutions it has meaſured the length of its ſtage, it is to be replaced at S, as before; which may be done in leſs than half the time you are winding up a watch; and if the ſtage be 6 foot long, not oftener than once in a whole week: The way of adjuſting this motion to the juſt meaſure of an hour, and rectifying its errors, is thus; *viz.* by the turning of a ſcrew inſerted at S, the ſtage may be elevated or depreſſed, and accordingly the movement will go faſter or ſlower; faſter, if raiſed up, and ſlower, if let down; and by making the horary circle moveable, and inſerting ſeveral ſmall boſſes or buttons here and there on its verge, it may with an eaſy touch of the finger be moved to the right and left, as there ſhall be occaſion, till the juſt time be brought to the point of the ſuſpended index.

The reaſon of this movement may be thus explained; let the circle L O D N Fig. 5, repreſent any circular body, whoſe centres of gravity and magnitude coincide at M; let this circular body be placed upon ſome level plane G G; and then it is evident that the angle of contact with that plane at *a*, will alſo be the point of its libration, and conſequently it muſt reſt there; becauſe both the momentum and obſtacle are equal: Let D E repreſent a deſcending plane, making an angle of contact with this circular body at *b*; and here it is manifeſt, it cannot reſt; becauſe the line of direction *r a*, which, while the body inſiſted on a level, divided it thro' the centres of gravity and magnitude into parts æquiponderate, is now removed to L D; which line L D falling without, or beſides the centre M, evidently deſtroys the æquilibrium of its parts, and therefore it muſt tumble down towards E; for in this caſe the momentum exceeds the obſtacle; the reaſon therefore of its deſcent now, being the overbalance of the parts L N D to the remaining ſection L D O, it muſt neceſſarily follow; that if ſomewhat equal to the exceſs of L N D above L O D were affixed to the limb of the quadrant O *a*, as at P; the circular body would then reſt as quietly at *b* as it did before at *a*; becauſe

cauſe L D O + P = L N D, that is, the obſtacle is equal to the momentum; nay this circular body will now reſiſt a greater force, and maintain its point of libration *b* more firmly on the declivity D E, than it could before, when it reſted on the point *a* in the level G G; the reaſon of which is evidently this, becauſe by the addition of the counterpoiſe P to the quadrant O *a*, the centre of gravity falls lower in the line of direction L D, and is removed from M to C, *i. e.* nearer to the point of libration *b*; and conſequently will keep the circular body more ſteady in its preſent poſition; and the ſame principle which is the cauſe of its reſt is alſo that of its motion; for let the numbers 1, 2, 3, 4, repreſent a train of wheel-work, wherein there is no material difference from what is found in a common watch, only the numbers of the teeth on the wheels and pinions are to be calculated in ſuch a manner, as that the motion of the whole train may correſpond to the aſſigned revolution of the body of the movement, which is to be once in 24 hours; it would be alſo expedient that a ſpiral ſpring were applied to its balance, as is uſual in the latter movement; but there is no occaſion for a fuſee; for the turns of the body of the movement, as it deſcends upon the ſtage, anſwer all the intentions of a ſtring or chain; and the contranitence of the weight P to the exceſs of L E D above L Q D ſerves inſtead of a perpetual ſpring, and the movement wants only a perpetual deſcent, to make its motion ſo; and whereas the great wheel in ordinary movements is placed as near the edge of the framing plate *f f*, as poſſible; in this caſe it muſt with its arbor or axis M poſſeſs the centre of the movement; becauſe this wheel is to carry the weight or power P by the vectis or lever M P, and that weight P muſt be always equi-diſtant from the centre of the movement; that whilſt the body of the movement performs its revolutions, the ſaid weight P, and the great wheel, to which it is affixed, may, without any conſiderable variation, continue in, or near the ſame poſition, wherein they now are; now ſuppoſe this weight P with its vectis M P to be quite taken out of the movement, and the body of the movement to be placed on a horizontal plane H H, its point of contact in that place is T; where it ſhould, but cannot reſt; becauſe the weight of that part of the train, marked with the numbers 2, 3, 4, removes the centre of gravity from M; and therefore on the oppoſite part of the movement, as about C Q, the inſide of the hoop, which forms the caſe, is to be loaded with a thin lining of lead, which may be a counterpoiſe to that part of the train; that ſo the whole body of the movement may, excepting only that P with its vectis is now laid aſide, reſt indifferently in any point on that horizontal plane; this reducing of the movement to an equilibrium of all its parts in the centre M muſt be performed by trials, that is, by raſping the lead at CQ: The centre of gravity being thus reduced to M, replace the weight P by the hole H, Fig. 7, on the arbor of the central wheel M; now let the body of the movement be placed on the declivity DE; and ſuppoſing P + LQD = LDE, then the body muſt needs reſt there; but becauſe the weight P is not now as in Fig. 5, fixed to any part of the quadrant QD, but hangs on the train of the wheel-work 1, 2, 3, 4, it evidently follows, that if its power be ſuperior to the reſiſtance of the train, then the whole body of the movement muſt needs deſcend towards E; by which it appears that there are two offices aſſigned to the weight or power P; the firſt is to be a counterpoiſe to the exceſs of the weight of LED above LQD; the ſecond is, that it be of force ſufficient to put the train into a motion, adjuſted in ſuch a manner as exactly to correſpond with the time aſſigned for the revolution of the whole body; ſo that all the difficulty conſiſts in ſuch an exact ſtating of the weight and power of P, that it may adequately ſerve both theſe intentions; and how eaſy this is, will appear from the following propoſitions: 1. That whatever the intrinſic weight of T be, as ſuppoſe four ounces troy, yet the power of that weight will be augmented or diminiſhed according to the different degrees of its elevation in the quadrant TQ; thus conſidering TM as a *Vectis*, its *Fulcrum* is M, the point, where it exerts its power on the train, is at U; then whatever force it has on the point U, in its preſent elevation of 45 degrees, it will acquire a greater by being raiſed to 50, 55, &c. and the greateſt of all in 90 degrees, at Q; and on the contrary, let it ſink to 40, 35, &c. its power on the point U will ſtill be diminiſhed, inſomuch that in T, it will be quite extinguiſhed; and therefore if P be of a competent weight to move the train at all, it will certainly move it in ſome degree of elevation or other in the quadrant QT. 2. If the weight P be conſidered as to its office of being a counterpoiſe to the body of the movement, it will perform this no leſs, while it hangs on the *Vectis* MP, than if it were faſt rivetted in the ſame place to the caſe of the movement; ſo in what point of the quadrant ſoever it will move the train, it may be alſo a counterpoiſe to the body of the movement; for, 1. At what point ſoever of the circle L E T Q, the line of declivity D E, makes an angle of contact; on the ſame point will the diameter S D fall at right angles with D E. 2. The line of direction L D will ever fall on the point of contact D, making an angle with the diameter, as S D L. 3. The angle S D L will be always equal to D E H; that is, as great as is the elevation of the line of declivity D E above the horizontal E H, ſo great will be the angle of diſtance between the diameter S D, and the line of direction L D. 4. The greater the angle of declivity is, the leſs will be the ſection L Q D; and ſo on the contrary, the leſs that angle is, the greater the ſection; and therefore, 5. The exceſs of the weight of L E D above L Q D muſt be alſo greater, by raiſing up the ſtage with the ſcrew at S; and that exceſs leſs by ſcrewing it down. 6. The lighter that part of the body is, which is repreſented by the ſection L Q D, the heavier ſhould be the counterpoiſe P; and that either in intrinſic weight, as in ounces and parts of ounces or potential weight, by being raiſed higher in the quadrant Q T. 7. The ſcrewing up the ſtage of the movement at S will raiſe the counterpoiſe higher in the quadrant Q T, by *prop.* 3, and therefore make it potentially heavier; from hence appears, both the reaſon of the due adjuſtment of the motion of the train to the exact meaſure of an hour, and what weight is to be aſſigned to P, that moves it: Having ſet the ſtage, by the help of the arched ſcrew, at the elevation of about 10 degrees, place the movement thereon, and try what weight at the end of the *Vectis* M P will ſtir the train; mean while holding the movement with the hand in ſuch a poſition, as the *Vectis* may make an angle of about 30 degrees with the perpendicular M T; then let the movement looſe, to undulate upon the ſtage; and when the vibration ceaſes, obſerve to what degree of the quadrant the *Vectis* points, and at the ſame time mind the pulſes of the balance; if, at this obſervation, the weight lie low, as, for inſtance, between 25 and 35 degrees of the quadrant, and the beats of the balance be conjectured not to differ much from their due time, the weight P is well enough proportioned; but if it chance to be much heavier than is abſolutely needful, that exceſs will be moderated by ſcrewing down the ſtage; and if it be not abſolutely too light, its defect will be compenſated by ſcrewing the ſtage higher; therefore, of theſe two extremes chuſe the former; for the fewer degrees P ariſes in the quadrant, beyond what is abſolutely neceſſary, it will be ſo much the better.

An eaſy Way of demonſtrating ſome of Euclid's Propoſitions; *by Mr.* Aſh. Phil. Tranſ. N° *162.* p. *672.*

THE propoſitions of *Euclid*, which Mr. *Aſh* endeavours to demonſtrate independently of the reſt, are the following; *viz.* the 32 and 47 of the firſt book; moſt of the ſecond and fifth books; and the firſt and ſixteenth propoſitions of the ſixth, together with their corollaries: In order to demonſtrate the 32d, he ſuppoſes it known, what is meant by an angle, triangle, circle, external angle, parallels, and that the meaſure of an angle is the arch of a circle intercepted between its legs, that a right angle is meaſured by a quadrant, and two right angles by a ſemi-circle; then in the triangle A B C Fig. 8. Plate VIII. the external angle B C E is equal to the two oppoſite internal ones A B C, B A C; for deſcribing a circle from the centre C and with the radius B C, drawing C D parallel to A B, theſe two lines, being always, equi-diſtant, will both have the ſame inclination to any third line falling upon them; that is, by the definition of an angle, they will make equal angles therewith; for if any part of C D, for inſtance, did incline more to B C than to A B, they would not be parallel; it follows therefore that the angles A B C, B C D are equal; alſo B A C = D C E, becauſe A E falls upon two parallels; but the external angle B C E = B C D + D C E, which was before proved to be equal to A B C, B A C, Q. E. D.

Hence, it may be inferred as a corollary, that the three angles of every triangle are equal to two right ones; for the angles A C B + B C E are meaſured by a ſemi-circle, and therefore are equal to two right angles: The 20, 22 and 31 propoſitions of the third book, which contains the properties of circles, are alſo corollaries from hence.

In order to demonſtrate the 47th, he ſuppoſes that two angles or two ſurfaces are equal, when placed on each other, neither does exceed; this being granted, the ſides about the right angle are either equal or unequal; if equal, let all the ſquares be deſcribed; the whole figure exceeds the ſquare of the hypothenuſe B C Fig. 9. by the two triangles M, U; and exceeds alſo the ſquares of the other two ſides A B, A C, by the two triangles A B C, and S; which exceſſes are equal, for M is equal to A B C, the two ſides about the right angle being two ſides of a ſquare upon AB, by ſuppoſition, equal to AC, and the third ſide equal to BC; therefore the whole triangles are equal; after the ſame manner S and U are proved to be equal; therefore the ſquare of CB is equal to the ſquares of the two other ſides, Q. E. D.

But if the ſides be unequal, let the ſquares be deſcribed, and the parallelogram LQ compleated; the whole figure exceeds the ſquare upon BC, Fig. 10, by three triangles, X, R, Z; and it alſo exceeds the ſquares LA, AD by the triangle ABC, and the parallelogram PQ; which exceſſes are equal; for Z is equal to ABC, the ſide $OC = BC$, $CD = AC$, the angle $D = A$, and $OCD = BCA$; which is manifeſt, by taking the common angle ACO from the two right angles BCO, ACD; therefore by ſuper-impoſition, or laying the one upon the other, the whole triangles are equal: In like manner X is proved equal to ABC, as alſo R; and the parallelogram PQ is proved to be double of the triangle ABC; and thus the exceſſes being proved equal, the remainders will be alſo equal; *viz.* the ſquare of BC to the ſquares of AB and AC. Q. E. D. The 35th and 36th of the third book, as alſo the 12th and 13th of the ſecond are manifeſt corollaries from hence.

The firſt ten propoſitions of the ſecond book are evidently demonſtrated, only by ſubſtituting ſpecies or letters for lines, and multiplying them according to the tenor of the propoſition; thus, to inſtance in one or two, call the whole line a, and its parts b and c, therefore $a = b + c$, and conſequently $aa = bb + cc + 2bc$, which is the very ſenſe of the fourth of the ſecond book: Thus alſo, let a line be cut into equal parts f, f, and let another line be added thereto; it is manifeſt, that $4ff + 4ff + 2ſſ = 2ff + 2ff + 2ſſ + 4ff$; which is the tenth propoſition of the ſame book.

Almoſt the whole doctrine of proportionals; *viz.* permutation, inverſion, converſion, compoſition, diviſion of ratio's, and proportion *ex æquo*; and conſequently the moſt uſeful propoſitions of the fifth book, are clearly demonſtrated by one definition, and that is of ſimilar or like parts, which are ſaid to be ſuch as are after the ſame manner, or equally contained in their wholes; thus the antecedents a and c are either equal to their conſequents, or greater or leſs; if equal, the thing is manifeſt; if leſs, then by the definition of proportionals a and c are like parts of b and e; therefore what ratio the wholes *b* and *e* have to each other, the ſame will *a* and *c* have, which is permutation; likewiſe *e* : *c* : : *b* : *a*, which is inverſion: So alſo, if from proportionals you take like parts, the remainders will be proportional; whence converſion and diviſion are demonſtrated; and if to proportionals you add like parts, the wholes will ſtill be proportional, which is compoſition, &c. If the antecedents be greater than the conſequents, the conſequents will be alſo the like parts of them, and the demonſtration exactly the ſame with the former.

The firſt propoſition of the ſixth book is proved by conſidering the geneſis of parallelograms, which are produced by multiplying or drawing the perpendicular upon the baſe; that is, taking it ſo often as there are parts and diviſions in the baſe; therefore the ſame proportion that R X, Fig. 11, ſingle hath to N X ſingle, the ſame hath R X multiplied by X Z, that is repeated a certain number of times, to N X multiplied by X Z, that is, repeated the ſame number of times; which is as much as to ſay, R X : N X : : the parallelogram R Z : the parallelogram N Z : Now that this propoſition is alſo true in oblique-angled parallelograms, is proved, becauſe they are equal to rectangled ones upon the ſame baſe, and between the ſame parallels, as does thus independently appear; the triangles R Q X and M P Z, are exqual Fig. 11; for R X = M Z, Q X = P Z, R M = Q P, therefore adding M Q to both, R Q = M P; if therefore, from theſe equal triangles you take what is common; *viz.* M L Q, the remainder R X L M will be equal to the remainder Q L Z P, to both which adding X L Z, the whole parallelograms will be equal, *viz.* R Z = Q Z. Q. E. D. That triangles alſo having a common baſe are in the ratio of their altitudes does hence follow; becauſe they are the halves of parallelograms on the ſame baſe: The demonſtration is exactly the ſame in priſms, pyramids, cylinders, and cones, having the ſame baſe.

To prove the ſixteenth of the ſixth book, he ſuppoſes *a*, *b*, *c*, *e* to be proportional; that is, granting *a* and *c* to be the leſſer terms; the ſame way that *a* is contained in *b*, ſo is *c* in *e*, and ſuppoſing *d* the denominator of the ratio; it will follow, that *b* is made up of *a* multiplied by *d*, and *e* of *c* multiplied by *d*; ſo that $ad = b$, and $cd = e$; draw therefore the extremes on each other, that is, *a* on *cd*, and the means, that is, *c* on *ad*; the factors being the ſame, the products *acd* and *cad* are the ſame, and conſequently equal. Q. E. D.

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The duplication of the cube is eaſily ſolved algebraically as follows, ſee Fig. 12, $a : 2x :: x : \frac{2x^2}{a} = p$ by 8 *Euc.* 6. $aa + 2ax - \frac{2x^3}{a} = \frac{4x^4}{aa}$ by 47 *Euc.* 1. therefore $a^4 + 2a^3x - 2x^3a = 4x^4$, and $a^4 + 2a^3x = 4x^4 + 2x^3a$, reſolving which equation into an analogy, it is, $a + 2x : 2a + 4x :: x^3 : a^3$, that is, $x^3 = \frac{1}{2}a^3$.

A Theory *of the* Tides *at the Bar of* Tonquin; *by Mr.* Halley. Phil. Tranſ. N° 162. p. 685.

THE effect of the moon upon the waters, in the production of the tides in this port of *Tonquin*, is the more wonderful and ſurpriſing, in that it ſeems different in all its circumſtances from the general rule, whereby the motion of the ſea is regulated in all other parts of the world; for, firſt, each flux is about 12 hours duration, and its correſpondent reflux, as long; ſo that there is but one high-water in 24 hours; again, there are in each month two intermiſſions of the tides, at the interval of about 14 days, when there is no ſenſible flood, or riſing of the waters to be obſerved, but the ſea is in a manner ſtagnant; thirdly, that the increaſe of the water hath its 14 days period, between the above-mentioned intermiſſions, and at the end of ſeven days, makes the higheſt tides; from which time the water again gradually abates, and the flood is weaker, till it comes to a ſtagnation; both increaſe and decreaſe obſerving the ſame rule in being exceeding ſlow in the beginning and end, and ſwift in the middle; laſtly, which is very uncommon, the riſing-moon in the one half of each month makes high-water, and the ſetting-moon in the other half.

To account for this ſtrange phænomenon, it appears that the intermiſſions of the tides happen nearly upon thoſe days wherein the moon enters the ſigns of ♈ and ♎, or paſſes the equinoctial; which divides the moon's courſe nearly into two equal parts, as well as the ſun's; and from hence it follows, that the tropical moons in ♋ and ♑, are thoſe, which cauſe the greateſt flux and reflux; it alſo appears, that the moon in northern ſigns brings in the flood, whilſt ſhe is above the horizon, ſo as to make high-water at her ſetting; and on the contrary, that whilſt ſhe is in ſouthern ſigns, it flows all the time the moon is below the horizon, and ſo makes high-water at her riſing: But it is to be obſerved, that tho' the moon paſs ſwiftly from ſouth to north, when ſhe is in, or near ♈, and from north to ſouth, when in, or near ♎; yet the motion of the ſea, which is the cauſe of this tide, is ſcarce diſcernible for three or four days, when the moon paſſes the ſaid equinoctial points; whence it appears, that tho' the moon's declination, or her diſtance from the equinoctial, be that whereby theſe tides are regulated, yet the increaſe and decreaſe of the water is by no means proportional to that of the moon's declination, that changing ſwiftly, where the increaſe of the water is obſerved to be ſloweſt: It ſeems therefore probable, that the increaſe of the waters ſhould be always proportional to the verſed ſines of the doubled diſtance of the moon from the equinoctial points; upon which hypotheſis, Fig. 13. Plate VIII. will give an elegant ſynopſis of the whole matter: Let A B be the bottom of the bar of *Tonquin*; C D a perpendicular thereto, whereon to meaſure the ſeveral depths of the water; C ♈, C ♎ the mean depth, when the water is ſtagnant, upon the moon's being in the equinoctial points, which is commonly about 15 foot; C ♋ *occid.* the high-water mark, when the moon is in ♋ or ♑, being about 24 foot; C ♑ *occid.* the height of the low-water mark, when the moon is in ♋ or ♑, being about 6 foot; ſo that the greateſt riſe of the water, on the tropical moons, will be about 18 foot; then dividing ♈ ♋ and ♎ ♑ into two equal parts in E and F, on theſe two points, as centres, deſcribe the two circles, each of whoſe radii are $4\frac{1}{2}$ foot, at which aperture of the compaſſes the ſaid circles are naturally divided in the ♉ ♊ ♋ ♌, *&c.* thro' which points, if lines be drawn parallel to the baſe A B, they will cut the perpendicular C D, in the heights of high and low-water marks, which will be at the entrance of the moon into the ſaid ſigns; ſo the greateſt depth of high-water, when the moon enters ♉, ♏, ♌, ♓ is but $17\frac{1}{4}$ foot, and the leaſt at low-water $12\frac{3}{4}$ foot; but when ſhe enters ♊, ♌, ♐, ♒, the high-water depth is $21\frac{3}{4}$ foot, the low-water but $8\frac{1}{4}$ foot, as appears by the figure: It is worth enquiring into, ſeeing this motion of the ſea is more or leſs as the moon is farther from or nearer to the equinoctial, whether ſome years there may not be much higher ſpring-tides than other years, according to the different obliquity of the moon's orbit to the equinoctial; for when the aſcending node is in ♈, as it was in 1671 and 1690, the moon in ♋ and ♑ deviates from the equator full $28\frac{1}{2}$ degrees; and but $18\frac{1}{2}$ degrees, when the ſame node is in *Libra*, as it was in 1680.

Expe-

Experiments concerning Digeſtion; *by Mr.* Ch. Leigh. Phil. Tranſ. N° 162. p. 694.

MR. *Leigh* prepared a digeſter or digeſting liquor from ſpirit of ſulphur, ſpirit of hartſhorn, the chyle of a dog, and the *Saliva*; its taſte was like that of meat vomited out of a full ſtomach, ſomething ſour, but it would not ferment with an alcali; it was pellucid, and without any ſmell; the ſalt, into which it did ſhoot, was cubical: Upon putting into a drachm of this liquor a piece of veal about the bigneſs of a nut, and ſetting it upon a digeſting furnace; in two hours time there came from the meat a liquor of the colour and taſte of chyle, and the meat afterwards was light, dry, and inſipid; and it afforded the ſame phænomena on beef, mutton, or any other meat: From theſe obſervations we may reaſonably conjecture, that by ſome ſuch menſtruum the meat is digeſted in the ſtomach, tho' not the only agent, it being requiſite in ſome, or in moſt animals. 1. That the ſtomach receive a gentle heat from the liver. 2. That it have a natural ſituation. 3. That it be aſſiſted by the *Omentum*; which latter may be inferred from thoſe animals, which have no caul, promoting digeſtion by doubling their hinder legs, and reſting their bellies upon them, as hares and conies. 4. Becauſe the ſtomach has a *Tunica Villoſa*, whereby it is enabled to divide the meat into parcels, which muſt neceſſarily facilitate the operation of the natural ferment; and becauſe, if it had not a *Tunica Villoſa*, the fleſhy tunicle would be apt to be too much diſtended by meat and drink, which would neceſſarily weaken the tone of the ſtomach. 5. It is requiſite that the guts ſhould form windings, otherwiſe the digeſted meat would be too ſoon diſcharged out of the ſtomach, and thus we ſhould be tormented with perpetual hunger.

The ingredients of the natural ferment ſeem to be, the ſaliva, the ſuccus or juice of the glands of the ſtomach, and a nitro-aerial ſpirits of the nerves: That the ſaliva is an ingredient, may ſeem probable from theſe reaſons; 1. Becauſe that by means of this, meats, tho' impregnated with different principles, may be made to mix with a menſtruum. 2. Since the ſaliva is impregnated with a volatile ſalt, it is probable, that that alſo may help digeſtion: The ſecond ingredient ſeems to be a liquor that is ſeparated by the glands in the bottom of the ſtomach; and it is obſerved that ſuch animals, as have the greateſt number of theſe glands, are the moſt voracious:

Laſtly, that the nitro-aerial ſpirits of the nerves are an ingredient of the ſtomachical ferment ſeems reaſonable from the arguments of Dr. *Mayow*, who reaſons thus; now ſince the animal ſpirits conſiſt of nitro-aerial particles, it will not be hard to conceive, how the above-mentioned effects are produced thereby in the ſtomach; for tho' the nitro-aerial ſpirit be not acid, yet iron is corroded thereby, vitriols are perfected, fixt ſalts are brought to a *Fluor*, and the compages of things are diſſolved by it, as by an univerſal menſtruum.

A Deſcription of a Bridge *without any Pillar.* Phil. Tranſ. N° 163. p. 714.

A Timber-bridge may be built 70 foot long, or ſomewhat more without any pillar under it, which may be uſeful in ſome caſes, where pillars cannot be conveniently built; it may conſiſt of two arches of timber; as that repreſented Fig. 14. Plate VIII. wherein *a c* and *b o* are beams 28 foot long, and *a b* is 32 foot long; under the angles are ſet two large braces *q l* and *s r*; at each end is a wall, on which are laid two beams *b h* and *a d*, each 20 foot long, and under theſe are two braces *d e* and *r h*; there may alſo be braces at the extremities of the arches, croſſing the bridge obliquely, and it may be laid with planks, and be railed; behind the walls are cauſeways *f d* and *h n*; the length of the bridge *c m o* is 70 foot; the height *k m* is 19 foot.

Of a Salt-Spring *on the Banks of the River* Ware *in* Durham; *by Mr.* Todd. Phil. Tranſ. N° 163. p. 726.

THERE is a ſalt-ſpring on the banks of the *Ware*, about a mile, or a mile and a half from *Durham*, at a place called *Salt-water Haugh* near *Butterby*, on the north-eaſt ſide of the town; it riſes in the middle of the river, and is to be ſeen and taſted only in ſummer; for in winter, when the river is high, it is covered, and it loſes its ſaltneſs in the freſh ſtream; the water does not riſe up in one or two places, but ſeems to bubble up equally in all parts of the channel, for 40 yards in length, and about 10 in breadth; for wherever in that compaſs, you remove the ſtones and ſand, you will perceive the water preſently to ſpring up; but what is moſt ſurpriſing is, that the ſalteſt ſpring iſſues out of the middle of a rock, and tho' but little in quantity, yet ſo ſtrong as to impart a brackiſhneſs to the water of the river for a hundred yards below; it is ſaid, in boiling, to afford a great quantity of bay-ſalt, which tho' not ſo palatable, yet is as uſeful as common ſalt; it tinges all the ſtones of a red colour.

A new Salival Duct, *and the Uſe of the* Glands; *by* Caſp. Bartholine. Phil. Tranſ. N° 164. p. 749. *Tranſlated from the* Latin.

SOME of the glands, which ſupply the cavity of the mouth with ſpittle have only one excretory duct, others more; thoſe that are more numerous, but ſmall, run together into the cavity of the mouth, and are peculiar to thoſe glands, which are found variouſly ſpread over the cheeks, under the tongue, in the palate and tonſils; but of the larger veſſels of the conglomerate glands, and which run in one duct, two only have been hitherto diſcovered on both ſides, of which the firſt, is ſuperior, ariſing from the parotid, a conglomerate gland, and was firſt diſcovered and deſcribed by *Steno*; the ſecond, which is inferior, and firſt delineated by *Wharton*, ariſes from the inferior maxillary gland; but to theſe two another veſſel of the ſame kind may be added, firſt obſerved by *Bartholine* in 1682, and which alſo may be called the inferior, becauſe ariſing from the ſub-lingual gland, it accompanies *Wharton*'s duct, and opens with a manifeſt orifice under the tongue in the ſame place with the former; and leads to another gland of the conglomerate kind near thoſe glands, from which the ſalival ducts, called by *Steno* the ſub-lingual, do ariſe; for as that gland, which in ſome animals lies near the inferior maxillary, and is large, in others is leſs, and ſituated more towards the extremity of the lower jaw, is entirely of the ſame ſtructure with *Wharton*'s inferior maxillary; ſo it has a like excretory veſſel, which is ſufficiently conſpicuous; whoſe lateral ducts ariſing from all the convolutions of the gland, have in the middle a common and pretty capacious trunk, which directly accompanies that other duct deſcribed by *Wharton*, and opens into the mouth within the gums at the extremity of the inferior jaw, amidſt certain firm *Papillæ*, which ſtrongly adhere thereto: This duct with its gland *Bartholine* firſt diſcovered in the head of a calf; in a ſheep the extremity of this duct terminates in thoſe very *Papillæ* which are obſervable in the inferior jaw under the tongue, and near it the orifice of *Wharton*'s duct opens in the ſame *Papilla*; in a bear near the *Frænum* of the tongue, on both ſides the orifice of each duct has its own peculiar *Papilla*; in a lioneſs, the orifices of both ducts do likewiſe open near the *Frænum* of the tongue, but in ſuch a manner as to have a peculiar ſphincter formed by the internal coat of the mouth; this gland from which *Bartholine*'s ducts ariſes is in this laſt animal larger and longer, with one ſide reaching to *Wharton*'s gland; and as it conſiſts of various convolutions of glands, ſo the ſeveral ramifications proceeding from theſe are detached to a common duct, which without the gland is made up of other ſmaller ducts, and in a direct courſe accompanies *Wharton*'s duct to its extremity.

The glands may be conſidered as ſo many ſieves, which ſeparate from the blood humours neceſſary for the conſervation of the individual; for ſince the blood is conveyed thro' the arteries to each part of the body, and before its return thence thro' the capillary veins, depoſites in ſome places various particles, which are diſcharged thro' peculiar veſſels, commonly called excretory ducts; that intermediate ſubſtance between the capillary arteries and excretory ducts, and which procures a paſſage, not to the whole maſs of blood, but to ſome parts ſecreted therefrom, and otherwiſe called a *Parenchyma*, may be properly enough denominated a ſieve: So in the blood, after the mutual action of the different humours on each other, particles of different kinds ſeparated from the whole maſs, find in each ſieve ſuitable *Meatus*'s, or pores; and a perſon, who rightly conceives this general deſcription of a ſieve, will underſtand the conformation of all the *Viſcera* furniſhed with excretory ducts; and ſuch are all thoſe commonly called glands, and uſually divided with reſpect to their conformation into conglobate and conglomerate.

Thoſe glands are called conglobate, which have an equal uniform ſurface, and conſiſt as it were of one continued ſubſtance, and have lymphatic veſſels for their excretories, whoſe diſtribution thro' the conglobate glands is in this manner; ſome are diſtributed from their origin on the ſurface of the glands; ſome proceed from the concave ſide of one gland to the convex of another; ſome again extend themſelves from the concave ſide of the ſame gland to their inſertion into the *Cava*, and that either immediately, or by means of the thoracic duct: So all theſe lymphatics which excern the humour ſecreted from the blood in the conglobate glands, do by a circulation return it again to the blood; ſuch glands are found in the meſentery between the veſſels that receive the chyle from the inteſtines, and the roots of the lumbary receptacle about the *Vena Porta*; between the lymphatics of the liver, and the root of the ſame receptacle; in the loins, groins,

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about the lungs, in the jaws, neck, above the throat, under the arm-pits, in the caul and in other parts: The author obſerved in the body of a woman in the fat on the left flank between the ſkin and abdominal muſcles, two conglobate glands with their lymphatics of a remarkable bigneſs; in another hydropic ſubject, the cavity of the abdomen was full of water, and all the glands, which ſeemed to be multiplied in an uncommon manner, were ſchirrous and full of purulent matter: It is certain that the true knowledge of the conglobate glands contributes not a little to account for ſcropholous tumours; for it is not uncommon to obſerve in theſe glands huge bags, full of a yellowiſh or chalky matter; which is eaſily accounted for from the groſſer parts of the lymph, which are ſecreted in the glands, and which find not an eaſy paſſage thro' them, being there gradually collected and forming theſe bags.

The conglomerate glands conſiſting, as it were, of various parts, and ſmaller glands, together with ſome inequality of ſurface, have lymphatic excretories, but of a quite different ſpecies from the preceeding; for they immediately diſcharge into peculiar cavities the liquor ſecréted from the blood in the glands; as the ſalival glands into the cavity of the mouth; the pancreatic into the duodenum; and all the glands of this kind, at leaſt of ſuch whoſe excretory ducts are hitherto known, ſupply an humour which contributes to the firſt reſolution or concoction of the aliments.

The Effects of the Froſt *in* 1683-4; *by Mr.* Jacob Bobart. Phil. Tranſ. N° 165. p. 766.

NOthing was more ſurpriſing, as well as univerſally known to be true, than the cleaving and ſplitting of trees in the ſevere froſt of 168¾; not only oaks, but elms, and aſh of conſiderable bulk and value, alſo walnut-trees in ſeveral places ſuffered thereby, and were very much rent; yet oaks were moſt of all affected, and ſome ſplit in ſuch a manner as to be ſeen thro', and with a noiſe like the report of a gun; theſe clefts were not towards the ſame point of the compaſs, but ſometimes on one ſide only, ſometimes on two, ſometimes three, and other times in four ſeveral places, dividing or quartering the tree, and ſometimes quite thro'; and theſe clefts were not only in the trunks, but continued in the larger boughs and limbs of the tree, and likewiſe deſcended into the ſuperficial roots, but not to thoſe that were very deep in the earth; the froſt, tho' ſevere, not reaching conſiderably deep;

but ſeveral ſhallow roots, ſo knotty as not to be wrought upon with beetle and wedge, were known to be cleft by the froſt; and it is to be doubted whether ſuch trees were ſo perfectly ſound timber; for if ſo, all might equally ſuffer, as being equally expoſed to the ſame air: But by what means ſoever this may happen, it is certain that ſome trees are much more ſound than others; and that ſome abound in innate diſeaſes and cavities, before they are cut down; theſe cavities and ſtretched veſſels are filled with too great a quantity of aqueous and indigeſted ſap, which being frozen takes up more room than when formerly in its liquid ſtate, and thus probably it cauſes thoſe breaches: It need not ſeem improbable that ice ſhould tear oaks and other trees, when we conſider its great force and elaſtic power; as appears from ſeveral experiments of the honourable Mr. *Boyle*, in his hiſtory of cold; for ſtrong veſſels of ſeveral kinds of metals being filled with water, cloſely ſtopped, and expoſed to the cold, could not withſtand the expanſive force of the incloſed ice, but were found rent and broken; and if we conſider the expanſion and ſpring of the air included in the cavity of the air-veſſels, which then undergoes a compreſſion from the congealed aqueous parts, thoſe exploſions, that are heard, may be eaſily accounted for.

Some trees and ſhrubs ſeem to have their veſſels ſtraitned, and as it were ſhrunk with cold; thus we ſee trees with ſhrivelled bark, and their paſſages half ſtopped, whoſe ſap now only ſqueezes and with difficulty forces it paſſage thro' the dried and narrow pores of the body and branches; and ſometimes this diſtemper is ſo prevalent, that whole branches of a tree are killed, when the other part is indifferent well: Some liquids, ſuch as eſſential oils, do rather ſhrink than expand by freezing; and empyreumatical oils will hardly freeze, but waſte; which may ſuggeſt what ſome trees are made of and in what they abound; as firs, pines, *&c.* which are capable of enduring the cold of *Norway*, and other countries.

Yew and holly were in ſome places entirely killed, and in many places they loſt their leaves and their bark was damaged; the furze in many places were quite killed; but common broom proved a degree hardier; in ſome places the ſunny ſide of a juniper-buſh, one of the moſt hardy of our native greens, was ſcorched between ſun and cold; ſo that it is hard to ſay, what is winter-proof, even among our natives, except box and ivy, which ſtood in defiance of all.

It is obſerved, that in dry mountainous, rocky and barren plantations, where trees, greens and other plants having been ſparingly fed, and not pampered with ſuch luxuriancy of ſap, as thoſe in the vallies and richer ſoils, eſcaped tolerably well.

In gardens, which are generally nurſeries of exotics, this calamity bent its force principally againſt winter-greens, ſuch as *Alaternus*, and the true *Phillyrea*; alſo common bays ſeemed in moſt places to be killed; laurel was in ſome places killed, in others half dead; roſemary, lauruſtine, *Halimus*, *Arbutus*, white jeſſamine were generally killed thro' the whole country: But if for the future in ſuch times of extremity, the ſurface of the ground, the bodies of ſuch things as are here recited, and fig-trees, were well covered with ſtraw to keep off the froſt, it might preſerve them to the enſuing ſpring, tho' their tops, being too large and high, and incapable of ſuch covering, might loſe their preſent leaves and beauty: Divers of thoſe with deciduous leaves were ſufferers, as *Arbor Judæ*, young plane-trees, *Paliurus*, the *Aleppo* aſh, in ſome places the locuſt-tree, and in moſt hedges the great common bramble, and others, which upon cutting do moſt of them ſpring again: Such greens as we have from abroad, as oranges, lemons, myrtles, pomegranates, and the perfuming jeſſamines, and divers other rarities, ſuffered extremely in many places, eſpecially in houſes of weaker defence: There was a great deſtruction amongſt plants, herbs and flowers, and thoſe were many of common uſe; as moſt of the artichokes in *England*, winter-colly-flowers, ſage, thyme, maſtic, lavender-cotton, and ſeveral others were generally killed; except ſuch as happened to be new-planted that year, and ſo low, that they had the kind covering of a little ſnow, which proves one of the moſt natural feeding and warmeſt covering of any, ſo far is it from being cold and unkindly to them.

The Reaſon of the Aſcent of the Quickſilver; *by Dr.* Liſter.

Phil. Tranſ. N° 165. p. 970.

IT is to be obſerved that the quickſilver is not affected, or very rarely with the weather in St. *Helena* or *Barbadoes*, be it either cloudy, rainy, windy, or ſerene; and therefore probably not within the *Tropics*, unleſs in a violent ſtorm or hurricane: In *England* in a violent ſtorm, or when the quickſilver is at the very loweſt, it then viſibly breaks and emits ſmall particles; which may be looked upon as a kind of fermentation, and conſequently at all times of its deſcent, it is more or leſs upon the fret: In this diſorder of the quickſilver, Dr. *Liſter* imagines that its parts are contracted and brought cloſer together; which ſeems probable, becauſe then the quickſilver emits freſh particles of air into the tube, whereby it is neceſſarily depreſſed and comes cloſer together; and that it is mixed with much air, appears from the application of a heated iron to the tube, one of the ways of freeing it from air, and from the ruſting of poliſhed iron immerſed therein: Now when the quickſilver riſes in the tube, which it certainly does both in hot and froſty weather, it may then be ſaid to be in a natural ſtate, free, open and expanded, which, it ſeems, it ever is within the *Tropics*, and with us only in very hot and very froſty weather; but when it deſcends, it is then contracted, as it generally is in our climate of *England*, and probably more or leſs ſo, in all places on this ſide the *Tropics*; this contraction plainly appears from the concave figure of both ſurfaces, not only in that of the quickſilver in the tube, but alſo in that which ſtagnates in the ciſtern: The difficuly ſeems to lie in the reconciling the ſame effect of the quickſilver's riſing in the tube, from ſuch ſeemingly different cauſes, as great heat and extreme froſt; but it is obſerved, that liquified ſalts will coagulate or cryſtallize, that is, return to their own proper natures, both in cold and heat; and therefore tho' moſt men practice the ſetting them in a cool cellar for that purpoſe, yet ſome, as *Zwelfer*, adviſe, as the beſt means of having them ſpeedily and fairly cryſtallized, to keep them conſtantly *in Balneo*; thus alſo the lympha of the blood becomes a jelly, if you ſet it in a cool place; and it is in like manner inſpiſſated by warmth: Again, it is no new opinion, that water is naturally ice; *Borrichius* the learned *Dane* hath ſaid ſomething for it; and it may be added in confirmation of that doctrine, that ſalt is naturally rock, that is, naturally foſſile not liquid; and yet nothing in nature comes near rice, not only on account of its tranſparency, but alſo its eaſy ſolution, and the ſudden impreſſions and changes the air makes upon it, ſo that it is ſcarcely to be preſerved in its natural ſtate of cryſtallization; ſalts alſo of all ſorts ſeem naturally to propagate themſelves in a hard ſtate, and to vegetate in a dry form; the like is to be obſerved in quickſilver, from its being a hard rock, and alſo from its aptneſs to aſſume upon all occaſions a more fix'd ſtate, as in its amalgamizing with almoſt all ſorts of metals: If therefore quickſilver and liquids be in a more natural ſtate, and have leſs violence done them, in very cold and very hot ſeaſons,

ſeaſons; the humours of our bodies, as liquids, muſt probably in ſome meaſure be affected accordingly; and that therefore cold is healthful, may be argued from the vaſt numbers of old men and women to be met with upon the mountains of *England*, comparatively to what are found elſewhere: Again, the blood itſelf, or the vital liquor of animals equivalent thereto, is in moſt kinds of animals ſenſibly cold; for the ſpecies of quadrupeds and fowls are not to be compared for numbers to fiſhes and inſects; there being in all probability above a hundred ſpecies of theſe latter, whoſe vital juice is cold, to one of the former.

That the Lacteals *frequently convey other Liquors beſides* Chyle; *by Dr.* Will. Muſgrave. Phil. Tranſ. N° *166.* p. 812.

1. DR. *Muſgrave* kept two dogs faſting, one for 48 hours, the other for three days, after which he opened them; and in both a conſiderable number of the lacteals appeared pellucid, like lymphatics; only they were not ſo full and turgid, as thoſe under the liver generally are, or as the lacteals themſelves are ſometimes obſerved to be; upon cutting ſeveral of them there iſſued out a tranſparent liquor. 2. A dog which had neither eat nor drank for three days, was ſuffered to lap a quart of common water; he was opened in an hour after, and the lacteals appeared pellucid in great numbers. 3. A third dog, after three days faſting, had a piece of fat meat given him; in an hour and a half after, he lapt a quart of common water, and in half an hour more he was opened; ſome of the lacteals appeared perfectly white, many were of a faint diluted white, but moſt of them were pellucid, eſpecially towards the latter end of the diſſection; in which time ſeveral, that at firſt were either of a lively, or of a fading white, were now become tranſparent: He ordered about three pints of broth to be given a dog, which had been kept faſting for 24 hours, and opening him in four hours, more, he obſerved all the lacteals, beginning at the *Duodenum*, to be of a perfect white colour; near the middle of the *Inteſtinum Ileum*, they began to be of a more diluted white, and a little farther, they were really pellucid, and as turgid to appearance, as thoſe that were white; after which, turning back again towards the ſtomach, he ſaw the ſame veſſels in as great numbers as at firſt, but the colour of moſt of them was changed, for they were now all pellucid; the ſame thing ſucceeded in a dog, kept

faſting two days, and then opened in three hours after lapping three pints of milk; about 15 of the lacteals, ariſing from the *Duodenum*, were white; above 100, proceeding from the *Inteſtinum Jejunum* and *Ileum*, were more or leſs tranſparent; as were alſo thoſe of the *Duodenum* at the latter end of the operation.

The experiments of the firſt kind do ſufficiently ſhew, that the lacteals convey not only chyle, which reſults from aliments lately taken into the ſtomach, but alſo another humour, which is probably ſeparated from the blood, and now returning to it again, which, by the above experiments, may be ſeen purely by itſelf, without any mixture of chyle; and it ſeems not unreaſonable to derive this refluent liquor, or at leaſt, part of it, from the cavity of the inteſtines; if we conſider that the pancreas, and *Glandularum Plexus Fragiformes*, not to mention the liver, do daily diſcharge a liquor into them: It ſeems alſo probable from the ſame experiments, that the lacteals are ſeldom or never quite empty at the ſame time; for tho' the chyle flows only in certain tides or periods, in proportion to the quantity of *Ingeſta* or aliments, yet the refluent liquor, running in a more conſtant ſtream, does, when there is no chyle, keep the lacteals from being abſolutely empty: And it is farther evident that this refluent liquor is, in its own nature, tranſparent, and paſſes thro' the lacteals, after long faſting, when no chyle is mixed with it: The experiments both of the ſecond and third kind ſeem to intimate, that a great part of the chyle itſelf is, in its paſſage thro' the lacteals, altogether limpid; againſt which it may be objected, that ſome of the lacteals were in a like manner pellucid in all the experiments of the three kinds; and therefore it does not appear, but that they may be filled with a refluent liquor in the two laſt caſes, as well as they certainly were in the firſt caſe; to which it may be replied, that in all the inſtances of the ſecond and third caſes, a conſiderable quantity of aliment was taken in by each dog, not long before his death; that ſome of this matter was ſeen in the *Primæ Viæ*, an argument it was not all diſtributed; that there is no way certainly known, by which liquors are diſcharged the *Primæ Viæ*, in this ſpecies of animals, beſides vomiting, ſiege, and by the lacteals; and ſeeing neither of the two former took place, it may not be unreaſonable to ſuppoſe, that part of this matter, was, at each diſſection, on its way thro' the lacteals to the blood: If therefore the liquor, ſeen in the pellucid lacteals of the two laſt kinds of experiments, did in a great meaſure (for the refluent liquor is not to be excluded entirely) conſiſt of the matter lately taken in before the dogs were opened; we may with good reaſon imagine, that water drank on an empty ſtomach, as it was in the ſecond caſe, by ſeveral other quadrupeds; and men, as well as dogs, will paſs the lacteals, not under a white colour, but rather pellucid, and ſuch caſes are not uncommon; particularly this ſeems to hold true in thoſe who drink great quantities of diuretic mineral waters; and what is here ſaid of water, is not unlikely to hold of ſeveral other liquors, as wine, beer, *&c.* at leaſt ſo far as that they may not paſs white thro' the lacteals: Again, if this principle be true, the third kind of theſe experiments will yet go farther, and argue, that the whole quantity of chyle, ariſing from ſome ſort of meats and drinks, taken either at, or near the ſame time; or from ſome ſorts of meat taken alone, is not always white; for the lacteals, which appeared perfectly white in the ſeveral inſtances of the third kind, were far inferior in number to thoſe that were pellucid in the ſame diſſections: From theſe premiſes there appears ſome reaſon to think, that the lacteals frequently convey liquors, which are not white; and that chyle may not improperly be divided into three ſorts at leaſt, *viz.* white, pellucid, and chyle of an intermediate colour; contrary to the opinion of thoſe anatomiſts, who thought it to be always white, as that word is contra-diſtinguiſhed from pellucid; altho' by chyle they underſtood, as Dr. *Muſgrave* likewiſe does, the effects of drink, as well as meat, concocted.

The Amianthus; *by Mr.* Edw. Lloyd. Phil. Tranſ. N° 166. p. 823.

THE *Lapis Amianthus*, or *Linum Foſſile*, as *Beſtinum* is found in no ſmall quantity in the pariſh of *Llan-Fairyng Hornwy* in the northern parts of *Angleſey*, where it runs in veins thro' a rock of ſtone, not unlike flint in hardneſs and colour; theſe veins are generally about ¼ of an inch deep, which is the length of the *Amianthus*, it being ſeldom longer, but often ſhorter; it is compoſed of a lanuginous matter, exactly reſembling that of pappous or downy plants; but ſo cloſe and compact, that, till you draw a pin, or ſome ſuch ſharp thing, croſs its grain, it appears only a ſhining ſtone, there being not the leaſt filament of lint to be perceived therein: In its natural form ſome of it looks whitiſh, and ſome ſtraw-coloured, but the whole is ſhining; if pounded in a mortar, the brightneſs diſappears, and the whole becomes whitiſh: *Note*, that above and beneath the veins, there is a very thin *Septum* of earthy matter between the *Amianthus*, and the ſtone to which it adheres: Upon putting a ſmall quantity of the lint in the fire, it grew red hot; but tho' it remained there ¼ of an hour, it was not perceived to be any thing conſumed: Some of it twiſted into a wick, and dipped in oil, gave as good a flame as other wicks, till the oil was conſumed, and the wick remained of the ſame proportion as at firſt: Upon pounding and ſearſing ſome quantity of it, it was brought to a paper-mill, and put into water in a veſſel juſt capacious enough to make paper with ſuch a quantity; it was very much ſtirred, and the workmen were deſired to proceed with it in their uſual manner of making paper, with their writing-paper mould, only to ſtir it about before they put their mould in; conſidering it as a far more ponderous ſubſtance than what they uſed; and that conſequently, if not immediately taken up, after it was agitated, it would ſubſide; the paper made of it proved but very coarſe, and too apt to tear: But this being the firſt attempt, there is reaſon to believe it may be much improved.

Some Experiments about Freezing; *the Difference between common freſh Water* Ice, *and that of Sea Water; alſo a probable Conjecture about the Original of the* Nitre *of* Egypt; *by Dr.* Liſter. Phil. Tranſ. N° 167. p. 836.

December 3d, 1684, at night, Dr. *Liſter* expoſed four glaſs-bottles in the open air to freeze upon the ground, *viz.* one of the red natron-water from *Egypt*; another of a ſtrong ſolution of *Nitrum Murarium* in fair water; a third of ſea-water taken up at *Scarborough*, and more than half evaporated; and a fourth of the ſulphur-well at *Knasborough*, that is, of natural brine evaporated to the ſame height with the ſea-water: *Note*, that *December* 4th, in the morning, the ſolution of *Nitrum Murarium* was half of it ice, but not any of the reſt; the 6th, in the morning, the bottle of *Nitrum Murarium* was moſt of it ice, the ſulphur-water had none that could be perceived, the natron had much ice at the bottom of the bottle, and the *Scarborough* ſea-water had ſome flakes of ice: The iſicles of the natron were prettily figured; thoſe of the ſea-water were oblong ſquares, brittle and tranſparent; upon ſetting the drained iſicles of natron before the fire, they were readily enough melted and diſſolved into water again; this ice was equally ſalt when in ice as in water, and much like its water

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as to taſte: In like manner having drained the ſea-water ice, and expoſed it before the fire, theſe iſicles became gradually ſoft and moiſt, but at length they rather evaporated than melted away; and having taken up a good thick lump of common ice, at leaſt a hundred times their thickneſs and bulk, this in a few moments, at the ſame diſtance from the fire, grew ſtill moiſter, and diſſolved into water; whereas the ſalt-iſicles after ¾ of an hour, lying before the fire, was at length dried into a white powder, which was perfect ſalt, all the moiſture being evaporated: Alſo ſea-water iſicles taſted very ſalt, when firſt taken out of the water: He repeated the ſame experiment of expoſing bottles of natural brine of *Knasborough* ſulphur-well half evaporated, and the ſame *Scarborough* ſea-water as above to freeze; but without any iſicles in the natural brine, tho' the ſame large ones, as above deſcribed, were obtained from the ſea-water, but not till after the ſecond night's keen freezing: Theſe ſalt-iſicles continued unthawed in the bottles, tho' they were brought into the houſe, and kept in a warm room long after all other ice within doors was melted; *viz.* till the 12th inſtant at night, when the iſicles alſo were diſſolved: From which experiments we may note; 1. That there may be ſalt-ice from frozen ſea-water. 2. That there is a real difference betwixt natural brine and ſea-water, as there is between the ſalts themſelves, which they yield. 3. That the great floating mountains of ice in the northern ſeas, if upon ſtrict trial they ſhould be found to be ſalt, are not only the effects of many years freezing, but alſo much of their magnitude may be owing to the natural duration of that ſort of ice: As to the nitre of *Egypt*, the experiments made about it at *Oxford* plainly ſhew it to be little different from ſal-armoniac; conſidering that it rains little or nothing, comparatively to the great heats of that country; and that the lakes there are only once a year furniſhed with freſh water from the overflowings of the *Nile*; alſo that vaſt tracts of land there, and all over *Aſia* are naturally covered with foſſil ſalt; again, that thoſe lakes are furniſhed with vaſt animals, as crocodiles, *Hippopotami*, and doubtleſs with a great variety of other ſmaller vermin; from all theſe circumſtances it is eaſy to imagine, that in an year's time, moſt of the ſalt-water of thoſe lakes hath paſſed thro' the bodies of theſe animals, and is conſequently become urinous, or ſalino-urinous, as is the nature and compoſition of factitious ſal-armoniac.

Obſervations on the Cicindela Volans, *or* flying Glow-worm; *by* Rich. Waller. Phil. Tranſ. N° 167. p. 841.

THE *Cicindela Volans* is rarely found in *England*; *Ulyſſes Aldrovandus*, *Lib.* 4. *cap.* 8. deſcribes it thus; the winged glow-worm hath its wings included in ſheaths of a duſky colour, the head on the upper part is covered, as it were, with a cowl of the ſhape of an inverted flat ſhield, and of the ſame colour with the ſheaths; its little head, which is jet black, is divided into two tubercles, or eyes, of the ſame colour; its tail conſiſts of rings, and is divided by ſeveral ſegments, in its extremity are two pellucid drops like fire, but inclining from a ſhining fiery colour to a green or blueiſh one, like the flame of ſulphur; and they are then beſt obſerved, when, upon compreſſing the tail, that tranſparent humour tends to its extremity, *&c.* It is deſcribed much to the ſame purpoſe by *Mouſet* and *Thomas Bartholin*, in his treatiſe *de Luce Animalium*; ſave that they are both miſtaken in allowing the male only to have wings, whereas they both fly alike; and they only differ in ſize, the female being ſomething the larger: Its light is very vivid, ſo as to be plainly ſeen when a candle is in the room, but its vibrations are unequal, and the colour greeniſh, like that of the creeping glow-worm: The luminous part is two ſmall ſpecks on the under ſide of the tail at its extremity; the ſhining continues for a little, after the tail is cut off, tho' it ſenſibly decays, till at laſt it be quite extinguiſhed; poſſibly the uſe of this light is to be a lantern to the animal in catching its prey, and to direct its courſe by in the night, which ſeems probable from its poſition on the under part of the tail, ſo that by bending it downwards, it throws a light forewards upon its prey; while the luminous rays in the mean time do not at all diſcommode its ſight, as they would have done, had this torch been carried before it; this conjecture is alſo favoured by the poſition of the eyes, which are on the under part of the head, and not on the top; by ſome contrivance or other it can conceal its light, and make a kind of dark-lantern.

Fig. 1. Pl. IX. repreſents the inſect with its back upwards, where it appears to be of the beetle kind; it is of a dark-brown unpoliſhed colour; when the caſe-wings are opened, it extends two very large membranous wings, faſtened to the upper part of the *Thorax*; its head is covered, as it were with a ſhield, or

broad brimm'd hat. Fig. 2. repreſents the animal laid on its back, to ſhew the two eyes under its cowl, or hat, which are black and very large, making up almoſt the whole head; they are moveable, ſo that the animal can thruſt them forwards to the edge of its hat; from between theſe, are diſcovered two hairy feelers, or perhaps bruſhes to cleanſe the eyes; between the eyes and the *Thorax* lies the mouth; on the *Thorax* are ſix legs, almoſt all of a length; the tail conſiſts of ſeven ſhelly rings, on the laſt of which are viſible two ſhining points. Fig. 3. ſhews the inſect on its back, as ſeen thro' a microſcope when dead; where A A repreſents the two long horns, feelers, or bruſhes, conſiſting of 10 roundiſh joints, beſides the firſt, which is as long as two of the reſt; they are all hairy, and like thoſe of ſome butterflies; B B the cowl, or hat over the head, which appeared of a ſpeckled brown, and yellowiſh colour, like tortoiſe-ſhell; C C the two eyes compoſed of innumerable ſmall glaſſy hemiſpheres in rows, to ſupply their defect of motion, by the number of their *Pupillæ*; DDDDDD the legs, of a ſhelly make, like lobſters, and jointed in the ſame manner; covered with many ſtiff hairs, tho' not ſo many as thoſe of the blue fly, repreſented by Mr. *Hook* in his micrography; the mechaniſm of the feet was much the ſame; only what is there called the pattens, were here wanting, if not broken off, and their uſe ſupplied by the gibbous part *ddd*; the claws *eeeeee* of the feet were ſhining, and very ſharp-pointed; the legs conſiſted of two long joints, and the feet of four more, beſides that which was armed with the claws; theſe ſeemed to be jointed into each other, and were all thick ſet with hairs or briſtles; E the *Thorax*, conſiſting of one ſhell only, of a poliſhed copper colour, ſtuck full of tapering briſtles, with a ſmall pit in the ſhell where each grew; F the tail, conſiſting of ſeven rings of the ſame browniſh colour, without hairs, except on the edges, which were ſet with them like a thin fringe, as the tails of lobſters, *&c.* are; theſe rings were of an unequal ſhining ſhell-colour; *ff* the back, or upper part of two or three rings of the tail, turned up to ſhew the work of the ſhell on that ſide: On the inſide of the laſt of theſe was the light placed; GGG the membranous wings, in every particular like thoſe of the blue fly, with hairs on the veins or quilly parts; H H the inſide of the caſe-wings, which were hairy, pointing all downwards; the outſide of theſe caſes was alſo very briſtly.

A De-

A Deſcription of a Siphon *producing the ſame Effects with that of* Wirtemberg; *by Dr.* Papin. Phil. Tranſ. N° 167. p. 848. *Tranſlated from the* Latin.

THE extraordinary properties of the *Sipho Wurtembur-gicus* are theſe: 1. That the orifices of the two legs are in the ſame line. 2. That tho' the orifices be but in part or half immerged in water, yet the water will riſe. 3. That this machine produces its effect, tho' continuing dry for a long time. 4. That either of the apertures being opened, and the other remaining ſhut for hours, or a whole day, and then opened, the water will flow out. 5. That tho' the apertures be in the ſame level and the legs be of an equal height, yet the water will run out. 6. That the water riſes and falls indifferently thro' either leg.

A A, Fig. 4. Plate IX. are two metallic veſſels, into which the two extremities of the ſiphon are inſerted; B C D E D C B is a ſiphon, whoſe orifices B B are to be placed in the ſame horizontal line or level; F is a tube ſoldered to the hole in the upper part of the ſiphon, and to be carefully ſtopped, after the ſiphon is exactly filled with water; now it is plain, that the water contained in the part C D hinders the admiſſion of the external air, to the upper part of the ſiphon E; the ſiphon therefore, being always full of water, providing it do not exceed a certain height, will infallibly produce its effect, immediately as ſoon as the water contained in the veſſels ſhall fill ſome part of either orifice B; and both orifices being partly filled with water, when in each veſſel A the ſurface of the water ſhall be in the ſame horizontal line or level; if you pour the leaſt quantity of water imaginable into either veſſel, a part of it will be conveyed immediately thro' the ſiphon to the other veſſel: The largeſt of this kind that has been hitherto made does not exceed 20 foot in height.

A new Way of cleaving Rocks; *by Mr.* Beaumont. Phil. Tranſ. N° 167. p. 854.

AT the lead-mines in *Mendip-hills* in 1683 the miners had found out a new way of cleaving rocks with gun-powder; the firſt inſtrument they uſe is made of iron and called a borer, Fig. 5. Plate IX. and it is 2 foot 2 inches in length; it is an inch ſquare at the ſteeled end from *a* to *b*, and ſomewhat leſs in the other part; the uſe of this inſtrument is to make a hole in the rock deep enough to receive the powder; the ſecond inſtrument,

ſtrument, called the gun, Fig. 17. is 6 inches in length, $1\frac{1}{4}$ in diameter, and has a hole drilled thro' it to receive the priming powder: The firſt inſtrument is managed thus, one man holds it on the rock, and turns it round, whilſt another beats it down with a hammer of 5 or 6 pounds weight; when the hole is made ſomewhat deeper than the length of the gun, they dry it with a rag, and put into it about 2 or 3 ounces of powder, over which they put a thin paper, and on it place the gun, which they bind firmly into the hole, by driving in, againſt the flat ſide of its upper part, the third inſtrument Fig. 18, called a little iron wedge, 4 inches in length, by the miners denominated a quinnet; when this is done, they paſs down a wire thro' the hole drilled in the gun, and pierce the paper which covers the powder, and then they prime the gun, and lay a train, after which they retire before the powder is fired; the paper is put at firſt over the powder, leaſt upon driving down the quinnet, the tools ſhould ſtrike fire and kindle the powder: Theſe inſtruments will be of great advantage to miners; for, beſide the ſaving of timber in a year for burning rocks, which is very conſiderable, it is known, that as ſoon as a man has fired his powder, and ſplit the rock, he may preſently go to work again, whereas after a fire is laid in a ſhaft, one can ſcarce go to work in 24 hours after, becauſe the rocks are too hot to be endured.

The Advantages of High-Wheels. Phil. Tranſ. N° 167. p. 856.

IT having been aſſerted by *Merſennus*, *Herigon* and Dr. *Wallis*, that the larger the wheels of a coach, *&c.* are, all other things being equal, the more eaſily they may be drawn over a ſtone or ſuch like obſtacle; a model of a part of a waggon was made, conſiſting of four wheels, two axes, and a board nailed upon them; the leſſer wheels were $4\frac{1}{3}$ inches high, and the bigger $5\frac{2}{3}$; *viz.* $\frac{1}{12}$ of the ordinary height of the wheels of a waggon; the weight of the model was almoſt $1\frac{1}{2}$ pound; there were alſo two other wheels $5\frac{2}{3}$ inches high, to be put on inſtead of the leſſer; the middle of the two axes were $6\frac{1}{4}$ inches aſunder; all the wheels turned very eaſily upon their axes: A piece of lead of $53\frac{3}{4}$ pounds averdupois was laid upon the model, ſo forward, that the leſſer wheels ſeemed to bear above $\frac{2}{5}$ parts of the weight; then the model was drawn with a ſtring laid over a pulley, whoſe top was $\frac{1}{4}$ inch higher than the top of the hinder axis, and the middle of this pulley was 7½ inches from the middle of the fore-axis; the leſſer wheels being put on, and the ſtring tied to the top of their axis: 1. Three pound drew the model on a ſmooth level table. 2. Twenty pound drew the leſſer wheels over a ſquared rod ¼ of an inch thick. 3. Thirty pound drew them over a round rod, a little more than ½ inch thick. 4. Thirty one pound drew them over a ſquare rod ½ inch thick. 5. Twelve pound drew the hinder wheels over the bigger ſquare rod: The ſtring being laid under the axis; *viz.* ⅜ of an inch lower than before. 6. Twenty nine pound drew the leſſer wheels over the bigger ſquare rod: Then the two bigger wheels being put on inſtead of the leſſer, and the ſtring lying over the axis: 7. Three pound drew the model on the table. 8. Twenty five pound drew the fore-wheels over the round rod. 9. Twenty five pound drew them over the bigger ſquare rod. 10. The ſtring lying under the axis, 16 pound drew them over the leaſt rod. 11. Twenty three pound drew them over the round rod. 12. Twenty three pound drew them over the bigger ſquare rod. 13. Thirteen pound drew the hinder wheels over the bigger ſquare rod: In all theſe experiments, the lead was laid exactly on the ſame part of the board; but yet when the leſſer wheels were taken off, the lead did not lean ſo much forwards, ſo that the hinder wheels were ſomewhat more preſſed than they were before: By comparing the ſecond, third, and fourth experiments with the tenth, eleventh and twelfth, it appears how much more eaſily a waggon, &c. might be drawn on rough ways, if the fore-wheels were as high as the hinder wheels, and if the thills were fixed under the axis; ſuch a waggon as this would alſo be drawn more eaſily, where the wheels cut in clay, ſand, or any ſoft ground; beſides, high wheels would not cut ſo deep as low ones: It is true low wheels are better for turning in a narrow compaſs than high wheels; but it ſeems probable that waggons with four high wheels might be ſo contrived, that there would be no great inconvenience in that reſpect; at leaſt, ſuch waggons as ſeldom have occaſion to turn ſhort, as carrier's waggons and the like: The difference obſervable in the eighth and eleventh experiments is agreeable to what is ſaid by *Stevinus* and Dr. *Wallis*; *viz.* that if a coach, &c. muſt be drawn over rough, uneven places, it is beſt to fix the traces to the coach lower than the height of the horſes ſhoulders. 14. A table 2½ foot long was ſet with one end 8½ inches higher than the other end, and the model being loaded as before, leſs weight by 6 ounces drew it up the table, when the bigger wheels were on, than when two bigger and two leſſer were on; becauſe, in the firſt caſe, there was almoſt the ſame direction of the motion of the model and of the ſtring that drew it; but not ſo in the ſecond caſe, wherein the fore axis was ſo much lower than the top of the pulley.

The Connough-Worm; *by Mr.* Molyneux. Phil. Tranſ. N° 168. p. 876.

THE connough-worm is ſaid to be the only poiſonous animal in *Ireland*; ſome of theſe worms are as big as a man's thumb, and above three inches long; and ſome of them live ſo long, as to have fine hair, thinly ſcattered over their bodies: The moſt experienced people of the country agree that it is poiſonous, tho' no ſatisfactory experiment has been made thereof: The reaſons of thinking it noxious, if ſwallowed by a beaſt, are theſe; firſt, the diſeaſe, imputed to this animal, ſeldom or never affects cattle but in autumn, and then only this inſect is to be found; ſecondly ſcarce any cattle, but ſuch as feed in low marſhy grounds, are affected therewith, and theſe are the places this animal haunts; thirdly, cows, which are greedy feeders, but eſpecially ſwine, that feed in low grounds, are the only animals troubled with this worm; fourthly, the worm is very rare, and not to be found in ſeven years, and ſo likewiſe is the diſtemper that proceeds from it: As to the ſymptoms that attend its venom, they are ſwelling in the head, and, which is a diſtinguiſhing one, a ſwelling and *Procidentia Ani*, inſomuch that the *Rectum* will hang out above half a foot: The cure of this malady in black cattle, is effected by a drench of the herbs bears-foot, rue, garlick, and butter and beer; in ſwine, raddle pounded ſmall and mixed with buttermilk; and theſe are only uſed by the *Engliſh* husbandmen; but the *Iriſh*, as they impute the malady to this inſect, ſo from it they take the remedy, for they ſay, that if a hole be bored in a tree, and this worm be ſhut up therein to ſtarve and die, the leaves and bark of that tree ever after infuſed in water, and given as a drench, cures the diſeaſe; there is another fancy as ill-grounded, which is, that if a man cruſh this animal and let the expreſſed juice thereof dry on his hands, the water, he firſt waſhes in ever after, given to the beaſt to drink, cures it: But Mr. *Molyneux* is of opinion, that this worm is no more poiſon than other caterpillars, of which ſpecies it is, and *Goedartius* in his book of inſects calls it the elephant-caterpillar; only the uglineſs of this worm, it being of a dark, duſky, and as they ſay, poiſonous colour, together with its largeneſs, whereby it exceeds the common caterpillar, has ſo wrought on the imaginations of the vulgar, as to give it the name of venomous.

Of a prodigious Os Frontis; *by Dr.* Tho. Molyneux. Phil. Tranſ. N° 168. p. 880.

DR. *Molyneux* meaſured a very large *Os Frontis*, which is reſerved in the medicine-ſchool at *Leyden*; it is entire, and differs not in the leaſt from that of a man, except in its largeneſs; and ſince there is no animal, eſpecially of the larger ſort, whoſe *Os Frontis* reſembles the human, it is not at all to be queſtioned, but this bone formerly belonged to a man, and one who was of a very large ſize; from its articulation with the naſal bones to the termination of the *Sutura Sagittalis*, on its convex ſide it meaſured $9\frac{1}{10}$ inches, tranſverſely from ſide to ſide $12\frac{2}{12}$ inches, and in thickneſs it was $\frac{1}{2}$ inch; whereas the ordinary proportion is $4\frac{1}{2}$ inches long, 6 broad, and $\frac{3}{4}$ thick; ſo that ſuppoſing this bone had the ſame proportion to his ſtature, which it has in other men to theirs, this man muſt have been 11 or 12 foot high: It is true ſome heads are very large in proportion to their bodies, yet generally ſuch ſculls want in thickneſs, as this did not, are ill-ſhaped and not proportionable.

An Hydrophobia; *by Dr.* Roger Howman. Phil. Tranſ. N° 169. p. 916.

A Patient at *Norwich* had been bitten by a mad fox in the right hand; in ſix weeks after he began to be affected with ſhifting or wandering pains, which ſtill encreaſed, eſpecially in his right hand, arm, ſhoulder and back, but ſo as not to be bed-ridden; he was adviſed to take a doſe of the common purging ſpirit of ſcurvy-graſs, which gave him 7 or 8 ſtools, and made him very faint and weak, and his right hand began to be paralytic, tho' his pain was much abated there, and where elſe it had been greateſt; he had bled freely at the wounds the fox had made, and they healed without any farther trouble, only at intervals he felt a little twinging pain in that hand and arm: Tho' the *Aquæ Pavor*, or dread of water, had not yet appeared, yet his heat was much encreaſed, and his pulſe intermitted every fifth or ſixth ſtroke on the right ſide only; he alſo looked ghaſtly and thin, but his eyes were ſparkling and fiery: Dr. *Howman* preſcribed the moſt temperate antiſpaſmodic and antiparalytic remedies to be mixed with the ſpecifics commonly uſed in a *Hydrophobia*; next morning, which was *Thurſday*, he complained of a reſtleſs night, and that then he had wholly loſt the uſe of his right hand; and tho' the pain was more abated, yet he was very hot and uneaſy; his pulſe was then much ſtronger than over night, but intermitting on the right ſide only as before; his countenance was ſomewhat more ghaſtly, yet his veins were very full as in the beginning and encreaſe of a fever; no *Hydrophobia* appearing, Dr. *Howman* adviſed him to draw 6 or 7 ounces of blood from the left arm, and the continuance of what he formerly preſcribed; he bled 8 ounces very freely, the blood was well coloured but very thick; the ſame day in the afternoon the grand ſymptom appeared; his heat was very great, and his pulſe very high, and intermitting in both wriſts; and if any thing were offered him to drink, either ſtanding or ſitting, he ſtarted, as if his head would have fallen backwards from off his ſhoulders, but when laid upon his pillow, he could, tho' with great difficulty and uneaſineſs, at times get down a ſpoonful; he then looked very thin and ghaſtly, and ſeemed afraid of every body that came ſuddenly near him, telling them, they ſtiffled him, or ſtopped or hindred his breath in coming ſo ſuddenly upon him; he was all along ſound in his judgment, his voice was broken and imperfect, as of thoſe perſons, whoſe tongue and other organs of ſpeech are turning paralytic; *Friday* evening, tho' all the ſymptoms were growing worſe, yet he could walk out of one room into another with very little help; but between 12 and 1 next morning he died, without any convulſive motions, ſighs or groans, as if in a moment there had been an univerſal *Paralyſis*.

From this relation it is to be obſerved: 1. That as the pains, which were like thoſe in a rheumatiſm, abated, the *Paralyſis* and fever encreaſed. 2. As the fever encreaſed, the intermiſſion of the pulſe became more frequent, tho' the pulſe were much ſtronger; but why it intermitted on one ſide only at firſt, is not eaſily accounted for. 3. That the imperfection of the voice, as well as the difficulty of ſwallowing were the effects of the *Paralyſis*, may probably be allowed, and be a ſatisfactory reaſon, why Dr. *Liſter*'s patient could not uſe the quill, which was given him to ſuck with. 4. That the thin ghaſtly aſpect of this patient, his defect of ſpirits and tonic vigour, was from a *Paralytic* original, is not unreaſonable to conjecture. 5. That the *Paralyſis* chiefly affected the muſcles of the head and upper parts, may be partly collected from his inability to hold his head ſteady at the approach of any liquor; the fear thence ariſing, cauſing him to ſtart, and his head to fall back in ſuch a manner, as if it would fall from off his ſhoulders. 6. And that his lower parts were leſs affected, is probable; becauſe two or three hours before his death, he could walk out of one room into another, even when what he ſpoke was hardly intelligible.

Obſervations on boiling Fountains *and ſubterraneous* Steams; *by Dr.* Tancred Robinſon. Phil. Tranſ. N° 169. p. 922.

THE water of the famous boiling fountain at *Peroul* near *Montpelier*, is obſerved to heave and boil up very furiouſly in ſmall bubbles; which manifeſtly proceed from a vapour breaking out of the earth; for upon digging any where near the ditch, and pouring other water upon the dry place newly dug, the ſame boiling was immediately obſerved; the like bubbling of water is alſo ſeen round about *Peroul* on the ſea-ſhore, and in the *Etang* itſelf: In order to diſcover the cauſe of this odd phænomenon, Dr. *Robinſon* took ſome of the ſand and earth out of the fountain and ditch, which when he put into veſſels, and poured the ſame water upon it, there did not appear the leaſt commotion or alteration, the ſurface of the water continuing very ſmooth, equal, and quiet; he found, in ſeveral dry places thereabouts, many ſmall ventiducts or ſpiracles at which the ſteam iſſued forth; at whoſe mouths placing ſome light bodies, as feathers, ſmall thin pieces of ſtraws, leaves, &c. they were ſoon removed: this vapour, upon the application of a lighted candle or torch, did not flame in the leaſt, as the fumes emitted thro' the boiling ſpring near *Wigan* in *Lancaſhire* do; ſo that here we have two different ſorts of ſteams cauſing theſe boilings, yet neither of the fountains are medicinal, or ſo much as warm; the like is related by *Varenius* near *Culm*, and by Dr. *Plot* in *England*: There are other boiling waters of a quite contrary temper, being actually hot to ſeveral degrees, ſo as to boil eggs, and other things put into them; as thoſe near the *Solfatara* not far from *Naples*, as alſo upon the top of mount *Zebio* in the duke of *Modena*'s territories, not far from his *Villa* near *Saſſuolo*; in the ſource of the emperor's bath at *Aix la Chapelle* in the dutchy of *Juliers*; and *Varenius* tells us, that in *Japan* there burſts out ſo hot and boiling a ſpring, that no water can be brought to the ſame degree of heat by the ſtrongeſt fire; that it retains its heat three times longer than common water; and that it does not flow continually, but for two hours a-day; and then the force and violence of the vapours are ſo great, that they remove large ſtones, and raiſe them to the height of three or four ells, with a noiſe reſembling the exploſion of a great gun.

From the preceeding hiſtory, we may take occaſion to reflect a little upon the variety of exhalations prepared in, and breaking out from the vaſt ſubterraneous magazines and repoſitories; ſome being cold and dry, reſembling air or wind, as thoſe near *Peroul*, and in the caverns of mountains, eſpecially thoſe of *Æolus*, and other hills of *Italy*, as alſo in mines; others are inflammable, and of a bituminous nature, tho' not actually warm, as thoſe near *Wigan* in *Lancaſhire*; there are alſo many ſteams very hot, ſulphureous, and ſaline; more eſpecially thoſe in natural ſtones, ſweating-vaults, grotto's, baths, and the vulcano's near *Naples*, *Bajæ*, *Cuma*, and *Puzzuolo*, as alſo in ſome of the ſubterraneous works at *Rome*; others are of an arſenical and ſuch like noxious qualities, as in the grotto *del Cane* on the banks of the *Lago Agnano*, in ſeveral mines, and in poiſonous ſprings and lakes: Now theſe various ſteams, meeting with, and running thro' waters, muſt produce a variety of phænomena and effects in them.

Whether this great diverſity proceed from the various breaths of the *Pyrites*, and the *Lapis Calcarius*, whilſt under their ſeveral ſtates and changes, or from other effluvia the doctor pretends not to determine; however, he is perſwaded that ſulphur is ſublimed from the *Pyrites*; eſpecially that gathered upon mount *Ætna*, *Veſuvius*, the *Solfatara*, and in the ſtones of S. *Gennaro*; for moſt of the ſtones and cinders, thrown out of thoſe mighty furnaces, do manifeſtly contain iron, as appears by the load-ſtone. As to that ſalt, which is taken by many writers to be a ſpecies of ſal-armoniac, found together with the ſulphur in the above-mentioned places, it appears to be a kind of *Nitrum Calcarium*; which ſeems to be confirmed from the great quantity of lime-ſtone round about *Naples*, and from the many beds thereof in the *Terra di Lavoro*, or *Campania Felice*.

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The Specific Gravities *of ſeveral Bodies.* Phil. Tranſ. N° 169. p. 926.

MARCH, 1685. The following bodies were gently poured into a veſſel of well ſeaſoned oak, whoſe concave was an exact cubic foot: Thoſe in the twelve firſt experiments were weighed in ſcales turning with one ounce: The pounds and ounces here mentioned are *Averdupois.*

	℔	℥
1. A foot of wheat, worth 6 *s.* a buſhel	47	8
2. Beſt wheat, worth 6 *s.* 4 *d.* a buſhel	48	4
3. The ſame ſort of wheat meaſured again	48	2
Both ſorts were red *Lammas* wheat of the laſt year.		
4. White oats of the laſt year	29	8
5. Blue peaſe of the laſt year, and much worm-eaten	49	12
6. White peaſe of the laſt year but one	50	8
7. Barley of the preceeding year	41	2
8. Malt of the laſt year's barley, and two months old	30	4
9. Field beans of the laſt year but one	50	8
10. Wheaten meal unſifted	31	0
11. Rye meal unſifted	28	4
12. Pump-water	62	8
13. Bay-ſalt	54	1
14. White ſea-ſalt	43	12
15. Sand	85	4
16. *Newcaſtle* coal	67	12
17. Pit-coal from *Wednesbury* 63, but this is very uncertain, on account of filling the interſtices	63	0
18. Gravel	109	5
19. Wood-aſhes	58	5

Another Liſt of the Specific Gravities *of Bodies, which are in Proportion as the following Numbers.*

PUmp-water	1000
Fir dry	546
Elm dry	600
Cedar dry	613
Walnut-tree dry	631
Crab-tree dry at a mean	765

Aſh dry at a mean, and of the outſide lax part of the tree	734
Aſh more dry about the heart	845
Maple dry	755
Yew of a knot or root, 16 years old	760
Beech dry at a mean	854
Oak very dry, almoſt worm-eaten	753
Oak of the outſide ſappy part felled a year ſince	870
Oak dry, but of a very ſound cloſe texture	929
The ſame tried another time	932
Logwood	913
Claret	993
Moil-cyder not clear	1017
Sea-water ſettled clear	1028
College plain ale the ſame	1028
Urine	1030
Milk	1031
Box the ſame	1031
Red-wood the ſame	1031
Sack	1033
Beer vinegar	1034
Pitch	1150
Pit-coal of *Staffordſhire*	1240
Speckled wood of *Virginia*	1313
Lignum Vitæ	1327
Stone bottle	1777
Ivory	1826
Alabaſter	1872
Brick	1979
Heddington-ſtone, the ſoft lax kind	2029
Burford-ſtone, an old dry piece	2049
Paving-ſtone, a hard ſort from about *Blaidon*	2060
Flint	2542
Glaſs of a quart bottle	2666
Black *Italian* marble	2704
White *Italian* marble tried twice	2707
White *Italian* marble, of a cloſer texture	2718
Block-tin	7321
Copper	8843
Lead	11345
Quickſilver	14019
Quickſilver	13593

The laſt experiment was tried with another quantity of quickſilver, which had been uſed in water in the preceeding experiment; however, it is rather to be depended on, becauſe a ſmall miſtake, tho' allowed for here in the calculation, was found in the weight of the glaſs containing the quickſilver in the preceeding trial.

The ſolids here mentioned, were examined hydroſtatically by weighing them in air and in water; but the fluids, by weighing an equal proportion of each in a glaſs holding about a quart: The numbers ſhew the proportion of gravity of equal portions of theſe bodies, but if portions of them equally heavy be taken, their magnitudes or bulks will be reciprocally proportional to their correſpondent numbers; *e. g.* a cubic foot of water is to a cubic foot of alabaſter in gravity, as 1000 to 1872; but a pound weight of water is to a pound weight of alabaſter in magnitude or bulk, as 1872 to 1000; ſo that knowing by the former table the weight of a cubic foot of water; and by this, the proportion of gravity between water and alabaſter; we may, by the *Rule of Three*, find the weight of a cubic foot of alabaſter, and ſo of any other of theſe bodies; or we may know their magnitude by knowing their gravity; ſo that an irregular piece or quantity of theſe bodies being propoſed, it is but weighing it, and the juſt magnitude may be found without farther trouble.

Of the Bogs *and* Loughs *in* Ireland; *by Mr.* Will. King. Phil. Tranſ. N° 170. p. 948.

AS to the origin of bogs, it is to be obſerved, that there are few places in our northern world, but have been famous for them, as well as *Ireland*; every barbarous ill-inhabited country has them; the *Loca Paluſtria* or *Paludes*, whither the ancient *Gauls*, *Germans*, and *Britons* retired when beaten, ſeem to be the very ſame with what is called *Bogs*; and one ſhall find, that thoſe places in *Italy*, which were barbarous, as *Liguria*, were infeſted with them; and therefore the cauſe of bogs ſeems to be want of induſtry; and to ſhew this, we are to conſider, that the ſprings, in which *Ireland* abounds, are generally almoſt dry in ſummer, and in thoſe places graſs and weeds grow plentifully; in winter they ſwell and run, ſoften and looſen the earth about them; now that ſwerd or ſurface of earth, which conſiſts of the roots of graſs, being raiſed up and made fuzzy or ſpongy by the water in winter, is dried in ſpring, and doth not fall together, but wither in a tuft, and new graſs ſprings thro' it, which next winter is again lifted up; and thus the ſpring is ſtill more ſtopped, and the ſwerd grows thicker and thicker, till at firſt it forms what is called a *Quaking-Bog*; and as it riſes and becomes drier, and the graſs roots and other vegetables become more putrid, together with the mud and ſlime of the water, it acquires a blackneſs, and becomes what is called a *Turf-Bog*; and it is probable, that when the vegetables rot, the ſaline particles are generally waſhed away with the water, in which they are diſſolved, but ſuch as are oily and ſulphureous remain and ſwim on the water; and this is that which gives turf its inflammability: To make this appear, it is to be obſerved, that in *Ireland* the higheſt mountains are covered with bogs, as well as the plains, becauſe the mountains abound in ſprings; now theſe being uninhabited, and no care being taken to clear the ſprings, whole mountains are over-run with bogs: Again, *Ireland* abounds in moſs more than any other country; inſomuch, that it ſpoils fruit-trees and quick-ſets; this moſs is of different kinds, and that which grows in bogs is remarkable; for the light ſpongy turf is nothing but a great number of the threads of this moſs, before it is ſufficiently rotten; and then the turf looks white, and is light; it is ſeen in ſuch quantities, and is ſo tough, that the turf-ſpades cannot cut it; in the north of *Ireland* they call it *Old-wives Tow*, it nearly reſembling flax; the turf-holes are in time filled up with it again, as well as all the little gutters in the bogs, and to it the red or turf-bog is owing, as likewiſe that the hardened turf itſelf is ſtringy, tho' there plainly appear in it parts of other vegetables; and it is probable, that the ſeed of this bog-moſs, when it falls on dry and parched ground, produces heath: Further it is to be obſerved, that the bottom of bogs is generally a kind of white clay, or rather ſandy marle, that a little water makes it exceeding ſoft, and when it is dry, it is all duſt; ſo that the roots of the graſs do not ſtick faſt in it; for a little moiſture looſening them, the water eaſily gets in between the ſurface of the earth and them, and ſwells it as a dropſy does the ſkin: Again, bogs are generally higher than the adjacent lands, and they are higheſt in the middle, the chief ſprings being generally there, from whence they dilate themſelves by degrees; beſides, if you cut a deep trench thro' a bog, you will find the original ſpring, and vaſt quantities of water will be diſcharged, and the bog ſubſide: It muſt be owned, that quaking-bogs may be otherwiſe produced; when a ſtream or ſpring runs thro' a flat, it is filled with weeds in ſummer, trees fall a-croſs and dam it up; then in winter the water ſtagnates more and more every year, till the whole flat is covered; after this there grows up a coarſe graſs peculiar to theſe bogs; this graſs grows in tufts, and their roots conſolidate together, and yearly grow higher, even to the height of a man; the graſs rots in winter, and together with the ſeed falls on the tufts, which ſprings up next year, and ſo ſtill makes an addition; ſometimes the tops of flags and graſs are interwoven on the ſurface of the water, and this gradually becomes thicker, till it lie like a cover on the water, then herbs take root in it, and by a *Plexus* of the roots it becomes very ſtrong, ſo as to bear up a man; ſome of theſe bogs will riſe before and behind, and ſink, where a man ſtands, to a conſiderable depth, and under them is clear water; theſe will in time become red bogs, but may eaſily be turned into meadow by cutting a trench to let the water run.

The inconveniencies of theſe bogs are very great, a conſiderable part of the kingdom being rendred uſeleſs by them; they keep people at a diſtance from each other, and conſequently interrupt them in their affairs: The land, which generally ſhould be the meadows, and fineſt plains, is covered with bogs; this is obſerved over all *Connaught*, but more eſpecially in *Longford*, and likewiſe at *Weſt-meath*, and in the north of *Ireland:* Theſe bogs greatly obſtruct the paſſage from one place to another, and on this account the roads are either very crooked and winding, or they are made at vaſt expence thro' bogs: Theſe bogs prove fatal to cattle, the chief commodity of the country; for in the ſpring, when they are weak and hungry, they venture in to the bogs, and fall into ſloughs or pits, and are either drowned, or hurt in the pulling out: The bogs afford a ſhelter and refuge to tories and thieves: The fogs and vapours which ariſe from them are commonly putrid, ſtinking, and very unwholeſome; for the rain that falls on them will not ſink, there being hardly any ſubſtance of its ſoftneſs, ſo impenetrable to rain as turf; and therefore rain-water ſtands upon them, and in their pits, where it corrupts, and is exhaled by the ſun, very little of it running away, which muſt of neceſſity infect the air: The bogs corrupt alſo the water, both as to its colour and taſte: Yet notwithſtanding, the woods and bogs were formerly an advantage to the natives, as they afforded a place of ſhelter and retreat upon any foreign invaſion, eſpecially from *England*, and it is for that reaſon they ſtill build near them; it was therefore an advantage to have their country unpaſſable: They are alſo now of ſome uſe; for the greateſt part of *Ireland* has its fuel from them; turf is accounted a tolerably ſweet fire, and when charked it ſerves to work iron, and even to make it in a bloomery or iron-work, and it is alſo reckoned the ſweeteſt and wholeſomeſt fire, and fitter for a chamber and conſumptive people than either wood, ſtone-coal or charcoal: Turf-bogs are remarkable for preſerving things a long time; a corps will remain entire therein for ſeveral years, as alſo trees, even birch or elder, which are very ſubject to rot; ſuch trees burn very well and ſerve for torches in the night: All the inconveniencies of theſe bogs may be remedied, and they may be made uſeful by draining, and generally all of them have a ſufficient fall for that purpoſe: The great objection is the expence; for an acre of good land in moſt parts of *Ireland* is about 4*s. per annum*, and the purchaſe 14 or 15 years; and therefore 3*l.* will purchaſe an acre of good land, and it is a queſtion whether that ſum will reduce a bog; but the following conſiderations may obviate that difficulty; *viz.* 1. An act of parliament ſhould be made, that ſuch as do not drain their bogs in a certain time ſhould forfeit them. 2. It is to be obſerved, that quaking bogs are always worth the draining, and one trench drains ſeveral acres; and when dry it generally proves good meadow, or the beſt graſing ground. 3. Every red bog is encompaſſed with a deep, marſhy, ſloughy ground, called the bounds of a bog; and one deep trench round the bog keeps out cattle, and turns the bounds into good meadow. 4. It is to be conſidered that this expence is only gradual and therefore inſenſible; that the money circulates amongſt the tenants, whereby they are enabled the better to pay their rents; that it is alſo a work of charity, by employing ſo many hands, and that it conduces to both the ornament and general benefit of the kingdom. 5. Even red bogs might be made fit for grazing at a much cheaper rate than hitherto they have been, if the following rules were obſerved. 1. A deep trench ſhould be made round the bog; this not only reduces its bounds, but contributes to drain it; it alſo ſerves as a common ſink into which all the drains diſcharge themſelves. 2. Obſerve how the little ſloughs run, and cut your drains a-croſs them; for one drain ſo cut is preferable to 3 or 4 cut lengthwiſe. 3. The firſt drains in the bog ſhould not be above 2 or 3 foot deep or wide; for deep trenches fill up again, becauſe of the ſoftneſs of the bog; when the ſurface of a bog is cut in little trenches, ſuppoſe at

20, 30 or 40 perch diſtance, and it is incredible how much it will be drained, that even cattle may graze on it all ſummer. 4. A year or two after the little trenches are made, and the bog a little dry, they are to be made 6 foot wide, and as deep as the ſoftneſs of the bog will allow; in a year or two more one or two of the trenches may be cut quite to the bottom of the bog. 5. All the tenants ſhould be obliged to cut their turf in theſe trenches, and thus prevent thoſe pits in bogs that are ſo pernicious to cattle. 6. When a bog is full of pits, a paſſage is to be cut from one pit to the other, thereby to make a communication with the common drain; and if theſe pits are once dry, there will grow graſs or heath at bottom, fit for grazing, and they will afford a ſhelter to cattle in ſtorms. 7. When the bog is dried, it thereby becomes better turf, and then a part of it is to be allotted for that uſe, and to be cut clear away; and the bog being removed, the bottom will make good meadow. 8. In order to improve bogs for further uſe than grazing, the ſurface muſt be either cut off or burned, or elſe earth muſt be brought and laid on it; ſanding or rather gravelling is a great improvement in this country; land ſo manured will yield corn for 12 or 14 years, and would yield graſs, if it was not ploughed ſo long, as to conſume all its ſubſtance, and deſtroy the roots of the graſs, which are not to be recovered in many years, beſides it is ſaid that gravelling is bad for graſs; but the contrary is apparent, eſpecially in bogs.

As to loughs or lakes, the natural method of improving them is to drain them as low as poſſible, and then turn the remaining water into fiſh-ponds; by planting a few trees about them, they may be made both uſeful and ornamental: As to thoſe places called *Turloughs*, *Quaſi Terreni Lacus*, or land-lakes; theſe are lakes for one part of the year of conſiderable depth, and level plains the remaining part; there are holes in theſe lakes, by which the water riſes in winter, and retires in ſummer; theſe lakes take up many hundred acres, which are the moſt pleaſant and profitable land in the country; the ſoil is commonly a marle, which, by its ſtiffneſs, hinders the water from turning it into a bog; and immediately on the retiring of the water, it hardens, and becomes a level graſſy field; theſe, if they could be drained, would be fit for any uſe, make either meadow, or bear any grain, eſpecially rape, which is very profitable; theſe lakes are chiefly in *Connaught*, and their cauſe is obvious enough, it being a ſtony hilly country; theſe hills abound in cavities, thro' which the water paſſes; and it is common

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common to have a rivulet ſink on one ſide of a hill, and riſe a mile, or half a mile from the place; the brooks are generally dry in ſummer, the water ſinking between the rocks, and running under ground; inſomuch that in ſome places where they are overflowed in winter, they are forced in ſummer to ſend their cattle many miles for water; there is a hole on a hill near *Tuam*, between two of theſe *Turloughs*, called the *Devil's Hill*, at which a great noiſe is heard like that of water under a bridge; when there is a flood in winter, one of the *Turloughs* overflows, and diſcharges itſelf into the hole; and the noiſe does, in all likelihood, proceed from a ſubterraneous ſtream, which in ſummer has room enough to diſcharge all its water, but in winter, when rain falls, the paſſages between the rocks cannot empty the water, and therefore it regurgitates and covers the flats: Theſe *Turloughs* are hard to drain, being often encompaſſed with hills, and then it is impracticable; and often having a vent at which they diſcharge a conſiderable ſtream; in that caſe it is only making that paſſage as low as the bottom of the flat, and it will prevent overflowing; it ſometimes happens that the flats are as low as the neighbouring rivulets, and probably they are filled by them; and in that caſe it is not only neceſſary to make the paſſage from the flat to the rivulet, but likewiſe to ſink the rivulet, which is very troubleſome, the paſſage to be cut being commonly rocky.

Sugar *made of the Juice of the* Maple. Phil. Tranſ. N° 171. p. 988.

THE ſavages of *Canada*, at the time of the ſaps riſing in the maple, make an inciſion in the tree, by which it runs out; and after they have evaporated eight pounds of the liquor, there remains one pound, as ſweet and as good ſugar, as that extracted from the canes: The ſavages had practiſed this art for a long time; there is made with this ſugar a very good ſyrup of maiden-hair, and other capillary plants.

A periodical Evacuation of Blood *at the end of the* Finger; *by Mr.* Aſh. Phil. Tranſ. N° 171. p. 989.

WALTER Walſh, a temperate man, of a ſanguine complexion and agreeable humour was, in the 43d year of his age, ſeized with a great pain all over his right arm, an exceſſive heat and redneſs in his right hand, and a pricking in the point of the fore-finger, on which there appeared a ſmall ſpeck, as if a ſmall thorn was run into it; and ſuppoſing it ſuch, he opened it, upon which the blood ſpun out in a violent but ſmall ſtream; after ſpending its violence, it would ceaſe for a while, and only drop, and then ſpring out with violence again; continuing thus for 24 hours, till at laſt he fainted away, and then the blood ſtaunched of itſelf, and his pain left him; from that time ever after, he was frequently troubled with the like fits, ſeldom having a reſpite of two months for 12 years, and they never returned oftner than in three weeks; he rarely bled leſs than a pottle at a time; the oftener the fit returned, the leſs he bled; and the more rarely, he bled the more; whenever the blood was attempted to be ſtaunched, he felt exquiſite tortures in his arm; no remedies proved effectual; he was afflicted with no other diſtemper; neither ſeaſon of the year, nor weather affected him; this bleeding was owing to no external accident, only if he drank more than ordinary he was apt to bleed; theſe frequent fits brought him at laſt very low, inſomuch that towards his latter end he bled but little, and that too like diluted water; he died at laſt of this diſtemper.

The changes of Weather *from the alterations of the gravity of the* Atmoſphere; *by Dr.* Geo. Garden. Phil. Tranſ. N° 171. p. 991.

THE air agrees with all other fluids in this, that it gravitates; and it has this peculiar property, which is not obſerved in other fluids; *viz.* that its ſpecific gravity is not always the ſame; now, according to the rules of the equilibrium of fluids, every fluid ſpecifically lighter than another, will aſcend and emerge above it; and every fluid ſpecifically heavier, will deſcend and ſubſide below it; again there is ſome certain proportion between the ſpecific gravities of the fluid of air, and of that which aſcends in vapours, and falls down again in rain; and if this proportion were always the ſame, it is likely we ſhould have no commixture of theſe fluids, but the vapours would either always float above, or always continue below; but this proportion of their ſpecific gravities is frequently changed; for it is known that water when warm is lighter than when cold; and yet poſſibly its ſmall particles, if figured according to *Des Cartes* conjecture, are more capable of aſcending in vapours in froſt than any other ſeaſon, as being more extended, and ſo having a larger portion of the fluid of air to ſupport them; and the daily obſervations of the different heights of the mercury in the barometer do make it appear, that the gravity of the atmoſphere is not

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not always the ſame: And now from theſe known properties a ſtatical account may be eaſily deduced of the riſing of vapours, of their floating in the air in clouds, and of their falling down again in rain; for if we may be allowed to ſuppoſe that when the atmoſphere is heavieſt, there is ſome ſuch proportion between its ſpecific gravity, and that of the fluid of vapours, as between water and oil; the vapours according to the known laws of fluids muſt needs aſcend, and ſo long as this proportion continues, they muſt neceſſarily float in the air; but when the gravity of the atmoſphere is changed, the vapours muſt fall down again: Now let us ſee whether this agrees with obſervation and experience; and firſt as to the aſcent of vapours, there is no determinate inſtrument which will indicate their aſcent, ſo certainly as the barometer does the change of the air's weight; for our common hygroſcopes are not very exact; beſides their change by moiſture ſeems to ſhew rather the falling than the riſing of vapours; yet there are two or three obſervations which ſeem to be certain indications of their aſcent; as, firſt, if the horizon and the remote hills ſeem ſmoaky and inconſpicuous, ſo that nothing can be ſeen at any diſtance, even tho' the heavens be not cloudy, but clear, and tho' there be no fog, nor any coping of clouds on the hills, which rather indicate the falling of vapours: Again, if, upon turning your eye to any diſtant part of the country round about you, it appear in an undulating motion, called by the country-people in *Scotland* ſummer-colts, this ſeems to be a ſign of the plentiful riſing of vapours; for this is only occaſioned by looking thro' an unequal waving medium, which makes frequent inflexions of the beams of light; juſt as an object ſeems to have a tremulous motion in all its parts, when viewed thro' ſmoke: Another indication of the aſcent of vapours ſeems to be the copious riſing of ſteams above waters, marſhy grounds, and fens, frequently obſerved in froſts, and cool ſummer-nights: To theſe may be added the redneſs of the ſun, ſo as to be looked upon with eaſe, and of the moon, a conſiderable time before ſetting, or after riſing: Now Dr. *Garden* affirms he made the foregoing obſervations, when the mercury was riſing, and conſequently in the increaſe of the atmoſphere's gravity; but on the contrary, when the mercury has been low, and ſo the gravity of the atmoſphere leſs, he obſerved none of theſe effects; but the remote hills appeared clear and diſtinct, and no waving was obſerved in the air, nor ſteams from the waters: To account for that great light and *Capræ Saltantes*, which are ſome nights to be ſeen towards the north, and which he uſually obſerved to happen when the mercury has been high; he ſuppoſes that their appearing in that quarter of the heavens, where the ſun is then below the horizon, is owing to the aſcent of the vapours ſo high in the atmoſphere, as to be beyond the earth's ſhadow in that part of the horizon, and ſo, by refracting the beams of light towards the ſpectator's eye, to cauſe that light, and thoſe *Capræ Saltantes*; it may be conſidered alſo, whether the red ſky in the evening, which betokens fair weather, does not proceed from the height of the clouds, occaſioned at that time by the encreaſe of the ſpecific gravity of the atmoſphere: Now as to the falling down again of the vapours, it is viſible by their gathering into thick and dark clouds, by the falling down of clouds and miſts on the tops of hills, and thick fogs in the air, and by their dropping down in rain, ſnow, *&c.* and that theſe do uſually happen, only when the mercury ſubſides a little, and conſequently when the gravity of the atmoſphere is leſs, appears from the conſtant obſervation of the changes of the barometer: Againſt this it may be objected, that it has been often obſerved, that even when the mercury in the barometer is riſing, there will be rain, and particularly, ſometimes in north-eaſt winds: To this it is anſwered that if the clouds have been carried for ſome time towards one quarter of the heavens by the winds, and then if the winds ſhould ſuddenly ſhift to another quarter; theſe vapours, which were formerly ſcattered into ſmall particles, and ſo did eaſily float, are ſuddenly driven together into ſmall drops, and ſo neceſſarily fall down in rain; and therefore the falling of rain, whilſt the mercury is riſing, is only obſervable upon the ſudden change of contrary winds.

In the next place let us conſider whether thoſe frequent commotions in the air, which we call winds, may not be accounted for on the ſame principles; that known definition of *Archimedes* is univerſally acknowledged; *viz.* that the parts leſs preſſed give way to thoſe that are more preſſed; ſo that if there be any portion of a fluid of a far leſs preſſure and reſiſtance than the reſt, the whole fluid runs in a current thither, till all be reduced to an æquilibrium: Now it is evident that the preſſure of the air is not always the ſame; and it is very probable that the gravity of the air is not alike changed throughout the whole atmoſphere in an inſtant; now this ſuppoſition affords an intelligible account of winds from the known nature of fluids; for when the air becomes ſpecifically lighter in one place, or its preſſure is leſſened, the neighbouring parts of the atmoſphere, whoſe weight is not thus diminiſhed, run thither in a current, till the atmoſphere thereabouts be reduced to an æquilibrium again; and according to the portion of air thus changed, and the leſſened or acquired degrees of weight and ſpring, the currents and winds are ſtronger or weaker, and of a longer or ſhorter continuance: Now obſervation and experience do agree in this, the mercury being found to ſubſide for the moſt part in the barometer at the riſing of winds; or at leaſt it is obſerved to be in motion, and either riſing or falling, and conſequently there is a change in the preſſure of the atmoſphere at that time: But the great difficulty ſtill remains, how to account for the different changes of the ſpecific gravity of the atmoſphere; and of this there can hardly be expected a ſatisfactory account, till we come to know the cauſe of gravity in general, and that of the weight of the air in particular; and therefore to ſuggeſt two or three hints, which may perhaps incite others to conſider the matter more narrowly; it is now, in the firſt place, almoſt generally owned, that there muſt needs be a fluid much more ſubtile than common air, and of a far greater preſſure than it, which is the cauſe of the continuity and coheſion of all terreſtrial bodies, and in which the air ſeems, as it were, to float, and to have the ſame relation thereto, as vapours have to air; and therefore if we could reach its nature and properties it might be conſidered what influence this might have on the change of the air's gravity: Or, ſecondly, ſeeing the affuſion of one liquor into another in chymical preparations will alter its ſpecific gravity, ſo that the bodies, which were formerly ſupported therein, will fall down and be precipitated, as particles of gold floating in *Aqua Regis* will be precipitated by the affuſion of another chemical colour, it may be conſidered, whether plenty of nitrous ſteams, or ſome ſuch mixture may not alter the air's ſpecific gravity: Or, thirdly, we may poſſibly come to a nearer reſolution of this, by conſidering the influence of heat and cold on the ſpring of the air: The air hath this peculiar property, that it is endued with elaſticity, as well as gravity, and therefore we are to conſider what influence the change of its ſpring may have on that of its weight; and it ſeems evident that the encreaſe of its ſpring diminiſhes its weight, and the leſſening of its ſpring encreaſes it; for on the encreaſe of the airs ſpring, the air is rarified, and ſo a leſſer portion of it preſſes on the ſubjacent fluid; but when it is leſſened, the air is condenſed, and ſo a greater portion of it preſſes on the ſubjacent body; for inſtance, let us ſuppoſe the ſpringy particles of air, to be like the ſpringy hairs of wool, or the ſpring of a watch, and that ſeveral millions of rows of them go to make up the cylinder of air, which from the top of the atmoſphere preſſes on the mercury in the barometer, and keeps it ſuſpended to the height of 30 inches; if we ſuppoſe this air to be rarified, ſo that all its ſpringy particles expand themſelves, and therefore ſome thouſands of theſe rows be removed from this cylinder; this now conſiſting of a fewer number of rows, muſt needs have a leſſer preſſure on the mercury, ſo that it will probably ſubſide to 29 inches; and thus it continues till the ſpring of the air be weakned, and ſo the particles be again crouded into a ſmaller ſpace: Now if this be found to hold in the theory, experience ſeems very well to agree with it; for Dr. *Garden* had obſerved that in cold weather and ſharp froſts the mercury riſes higheſt in the barometer, and if foreign meaſures agree with ours, that it is uſually higher here than in *France* or *Italy*; to this he ſubjoins two or three obſervations, which may ſerve to confirm what has been ſaid; and the firſt is of the courſe of the weather under or near the *Line*; as to which *Purchas* in his *Pilgrim* aſſerts, that in *Braſil* and *Guiana* in *America*; in *Guinea*, *Congo*, and *Æthiopia* in *Africa*; in the *Eaſt-Indies* and the *Maldives*, they have almoſt continual floods of rain from about the beginning of *May* to the end of *Auguſt*, which they call their winter; and the reſt of the months of the year, fair and clear weather, and which they call their ſummer; ſo that when the ſun is neareſt them, they have conſtant rains; and when remoteſt, fair weather; and this, among other cauſes, may be owing to the rarefaction of the air, and the leſſening of its ſpecific gravity, ſo that the vapours in the neighbouring parts of the air do all flow thither, and deſcend in floods of rain; and this is reckoned to be the cauſe of the inundation of the *Nile*, and ſome other rivers; ſo perhaps this may alſo be the reaſon, why thoſe countries, which border on them, and are ſomewhat remoter from the *Line*, ſuch as *Egypt* and the like, have ſeldom or never any rain: The ſecond obſervation is on the baroſcope, *viz.* that when the wind is north, north-eaſt, or north-weſt, the mercury ever riſes, and ſo the air is heavier; but when the wind comes from the ſouth, ſouth-eaſt, or ſouth-weſt, it falls, and ſo the gravity of the air is leſs; by which may be ſeen, what influence cold and heat have on the weight of the air; and a cold wind is ſaid to ſwell the ſails of a ſhip more forcibly than a warm wind: The third obſervation is on an experiment of the honourable Mr. *Boyle*, who made by diſtillation a blood-red liquor, which chiefly conſiſted of ſuch ſaline ſpirituous particles, as may be obtained from the maſs of blood in human bodies; this liquor is of ſuch a nature, that if a glaſs phial, about half filled therewith, be kept well ſtopped, the liquor will remain quiet without emitting any ſmoke; but if the phial be unſtopped, ſo as the external air be admitted, in a quarter of a minute or leſs, a copious white ſmoke will be elevated, which will not only fill the upper part of the glaſs, but be plentifully diſcharged into the open air, till the phial be again ſtopped: And a little after, he adds, that if the unſtopped phial were placed *in Vacuo*, it would not emit any viſible ſteams at all, nor would they ſo much as appear in the upper part of the glaſs that held the liquor; whereas, upon gradually reſtoring the air, the fumes would firſt riſe in the empty part of the phial, and from thence into the capacity of the receiver; that likewiſe when the air was pumped out, they would alſo accompany it, and the red ſpirit, tho' it remained unſtopped, would emit no more fumes, till the admiſſion of new air; ſo far Mr. *Boyle*: Such then was the proportion between the gravity of the vapours of this red liquor and the air, that the latter being in its ordinary degree of gravity, the vapours aſcended; but the gravity of the air being much leſſened in the receiver by exhauſting much of it, and ſo expanding the ſpring of the reſt, it was incapable of elevating theſe vapours.

The Gravity *of the* Air; *by Dr.* Wallis. Phil. Tranſ. N° 171. p. 1002.

THE notion of the weight and ſpring of the air hath been ſo well eſtabliſhed by innumerable experiments, that hardly any conſidering perſon now doubts of it; and it hath baniſhed the notion of a *Fuga Vacui*, formerly received, by ſhewing an efficient cauſe of thoſe effects, for which before we could only pretend to a final cauſe: The firſt hint of it was owing to *Galileo*'s diſcovery, *viz.* that water, by pumping, could not be raiſed higher than about three or four and thirty foot of our *Engliſh* meaſure; which was a certain argument, that the cauſe of thoſe effects, commonly aſcribed to a *Fuga Vacui*, was but of a finite force; whereas, if nature's ſhunning a vacuity had been the true cauſe, it muſt have operated without limitation; upon this, that *Lyncean* philoſopher, as he was called, did happily light on the counter-balance of the air, as the true cauſe; and that therefore air, which before was thought to be a light body, was but comparatively ſo, and had indeed a poſitive gravity, tho' leſs than that of other bodies, which we are converſant with: This notion was happily purſued by *Torricellio*, *Galileo*'s ſucceſſor, who rationally argued; that if the counterpoiſe of the air was ſufficient to raiſe and ſuſtain water at that height, and only at that height; then it muſt be a juſt counterpoiſe to a lighter liquor at a greater height; but to a heavier, at a leſſer height; and making an eſſay thereof on quickſilver, he found it to ſucceed accordingly; and in a juſt proportion to the reſpective gravities of thoſe fluids: And he hath, by this means, made the experiment, commonly called the *Torricellian*, much more manageable with quickſilver, in tubes of about 33 inches *Engliſh* meaſure, than before with water, in much longer tubes: In purſuance of this notion, we find, by ſeveral ſorts of baroſcopes, not only that the air hath gravity, but that it hath a different gravity at different times, and in different places, according as its counterpoiſe is capable of ſuſtaining quickſilver at different heights; ſometimes a little lower than 28 inches, ſometimes a little higher than 30, and at other times at ſome mean height; which different weight of the air may reaſonably be ſuppoſed, partly to proceed from, and partly, as Dr. *Garden* has rightly intimated, to cauſe the difference of weather and winds: That there is in the air a body more ſubtile than the fumes and vapours mixed therewith in our lower region, and which, together with them, conſtitutes that heterogeneous mixture, commonly called air, ſeems to be very certain; but whether that ſubtile body, be, as Dr. *Garden* ſuppoſes, much heavier than our common air, may be matter of doubt; and Dr. *Wallis* rather thinks it is not, not having hitherto had any cogent experiment, either to prove it heavy or elaſtic; but it may, for ought is known, be void as well of weight as ſpring; and what is found of either in our common air, may be attributed to the other mixtures therein; and the air being of a different gravity at different times, and in different places, may be conſidered as a fluid, whoſe parts are in ſome places heavier, and in others lighter; and therefore it is much the ſame thing, as if they were different fluids of different ſpecific or intenſive gravities one from the other: Now, when ſeveral fluids, or ſeveral parts of a fluid, are thus of different weights; they will from the general nature of heavy fluids, when undiſturbed, change places with each other, till the heavier becomes loweſt, and the lighteſt uppermoſt: And this not only as to the minuter parts, but much more as to larger parcels; as when oil, wine, water, beer, and other liquors, are put together into the ſame veſſel: And the ſame thing will happen, if ſome parts of the ſame liquor, do accidentally acquire, by expanſion, or otherwiſe, a greater degree of lightneſs than the other parts; as when water, beer, or other thin liquors are gradually heated by a fire underneath; the lower parts, being firſt warmed, aſcend to the top, whilſt the colder and heavier ſubſide; whence the top is warmer than the bottom; but, in caſe what is heated, be of a thicker conſiſtence, ſo as that the parts cannot readily ſhift places, that at bottom will be hotter: From ſuch conſiderations as theſe, Dr. *Garden* doth well obſerve, that ſome parts of the air being thus, by rarefaction, or increaſing its ſpring, or otherwiſe, become lighter than others; theſe heavier parts, ruſhing into the place of the lighter, may cauſe a wind from theſe parts: And this ſeems to be very true; tho' ſuch accidents happening very variouſly and uncertainly, will cauſe ſuch confuſion of motions, and diſturbance of each other, that it will be hard to reduce them to any certain rule: But to this, Dr. *Wallis* adds the earth's diurnal motion compounded with its annual; the one in ſome parts accelerating, in others retarding the other; and the difference of the latter at different times of the year, by reaſon of the obliquity of the ecliptic, and at different times of the month, becauſe of the moon's different poſition, whereby the annual motion of the earth is affected; and the different place of the earth and moon, as to the aphelion or perihelion of the one, and the apogæon or perigæon of the other, ſeem greatly to influence not only the tides, but alſo the winds; eſpecially the breezes and trade-winds, which at certain times of the day, month, or year, are obſerved to blow conſtantly, or moſt frequently, from a particular point: And it is a thing not fully aſcertained, that the body of earth and water, or the terraqueous globe, is exactly ſpherical, being poſſibly an oblong ſpheroid, with a longer axis from pole to pole, than diameter at the equator, which, together with the compound motions above-mentioned, may conſiderably diſturb the air: Nor is it certain, that ſea and land are ſo adequately adjuſted, that their centre of gravity coincides with their centre of magnitude, and thus the confuſions in the motions of the air will become greater.

From the comparative weight of the air at different times, Dr. *Garden* deduces the riſing or falling of vapours; and this is certainly to be admitted; only Dr. *Wallis* adds, that theſe ſtatical principles do chiefly then take place, when things are in other reſpects at reſt; but when they are in motion, it is oftener otherwiſe; and in ſuch caſes, we are, beſides the reſpective gravity, to take into conſideration the force, impulſe, or impetus, ſuperadded to the reſpective gravity of the parts of matter; thus in a jet of water, the water is thrown up into the air to a great height, not becauſe it becomes lighter than air, but on acconnt of the impreſſed force: And this Dr. *Wallis* takes to be the cauſe of fumes, vapours, &c. which aſcend in the air; not that they are lighter than it, but becauſe they are impelled upwards, either from the bowels or ſurface of the earth by an external force: And that ſuch fumes are projected upwards from the bowels of the earth, and ſome of them with great violence, is undeniable, from the inſtance of earthquakes and other eruptions; and to ſuch cauſes Dr. *Wallis* attributes the origin of winds, and the aſcent of moſt other things into the air: Dr. *Garden* ſuggeſts another notion of great importance as to this affair, and that is the weakening or ſtrengthening the ſpring of the air; and this latter is either by compreſſion or by heat; for if the ſame quantity of air be compreſſed into a ſmaller ſpace, its ſpring becomes ſtronger; as is plainly ſeen in the wind-gun, and other compreſſing engines: Again, the ſame quantity of air included in a cloſe veſſel, will, by the application of heat, have its ſpring ſtrengthened; as is obſervable in all thermometers: If the ſpring be ſtrengthened by compreſſion, it is manifeſt, that the intenſive gravity muſt be thereby encreaſed, becauſe the ſame quantity of air, and conſequently of weight, extenſively taken, is now contracted into a leſs ſpace, which therefore muſt be intenſively heavier, as being the ſame weight in a ſmaller bulk; now this may poſſibly as a greater preſſure, or ſtronger ſpring, force up the vapours under it with a greater impetus, and ſo make them fly higher, and not become lighter, but rather the contrary, as preſſing them cloſer together; much leſs make them ſpecifically lighter than the air itſelf: If the ſpring of the air be ſtrengthened by heat; this rather diminiſhes its intenſive gravity, by dividing its parts farther aſunder, whereby it takes up a larger ſpace; now, in caſe this air be, by a cloſe veſſel, ſo confined as not to expand upwards, it will certainly preſs the ſtronger on the ſtagnant mercury below, and make that in the tube riſe higher; but in caſe it be unconfined, as in the open air, it may as well expand itſelf upwards, by making the atmoſphere in this part ſo much the higher; nor is there any neceſſity as to the ſubjacent parts, that the atmoſphere ſhall be every where of the ſame height; for the laws of ſtatics, as to the ſubjacent parts, may be equally preſerved without it, the greater altitude compenſating for the levity of the parts; as when a portion of the ſea is covered with a fleet of ſhips, the lower parts are equally preſſed, partly by the water, and partly by the ſhips, tho' the tops of the ſhips be higher over ſome parts than the ſurface of the water over others; only, in ſuch caſe, the upper part of the atmoſphere, being fluid, may flow over the other parts on either ſide, if lower; and ſo leiſurely reduce itſelf to an equal height in all parts: But tho' the ſpring of the air, encreaſed by heat, may thus expand itſelf upwards, yet becauſe it preſſes every way, it muſt alſo produce the ſame effect downwards, and thereby preſs harder on what is below it; and becauſe it will require time to work upwards gradually, before the effect reach the top of the atmoſphere; and becauſe by ſuch a dilatation of its parts, more ſpace is left in the intervals to receive what is preſſed; it is reaſonable to believe, that in ſuch caſes, the preſſed vapours, all other things being alike, may riſe more copiouſly, than when the ſpring of the air, for want of heat, is leſs ſtrong; the rather, becauſe the ſame heat, which thus ſtrengthens the ſpring of the air, doth alſo rarify the vapours, and make them lighter; and it may alſo encreaſe the ſubterraneous heat, or whatever elſe it is, that drives them upwards; notwithſtanding all which, we have more rains in winter, which ſhould argue, that more vapours do then riſe to ſupply them: But Dr. *Wallis* ſuſpects, that in this whole buſineſs of ſtrengthening the ſpring, we may be under a miſtake; and what we think to be produced on the open air, is really effected on the quickſilver, or rather on the air latent therein: And the doctor explains himſelf thus, we find in very hot weather, and alſo in froſty weather, that the quickſilver in the tube commonly ſtands very high; from whence we are apt to conclude, that therefore the outward air preſſes very hard on the ſtagnant quickſilver, without the tube; which account, according to the doctor, ſeems not to be ſatisfactory; for, he ſays, we are to conſider, that, in filling the tube with quickſilver, before it be inverted, if great care be not uſed to cleanſe it from air, many aerial particles will remain mixed therewith;

which, while their ſpring is weak, are eaſily preſſed by the weight of the quickſilver ſo cloſe, as hardly to be diſcerned otherwiſe than by the effect; but when by the external heat, their ſpring is ſtrengthened, they expand themſelves, and cauſe the quickſilver to ſwell in bulk, without encreaſing its weight; and conſequently to ſtand higher, tho' not to preſs heavier: And the ſame ſolution may poſſibly ſerve for its ſtanding ſo high in froſty weather; for it is known, that water, tho' it contract with cold, yet, when it is frozen, it expands itſelf, which makes ice lighter than water, and ſwim upon it; now, if in the quickſilver there be lodged particles of water, as well as of air, we have either way an account of this phænomenon, if both be alike expanded by freezing; for the quickſilver will ſwell, and ſo ſtand higher, without encreaſing its weight; and conſequently without arguing a greater weight of external air preſſing on the ſtagnant quickſilver.

A ſtrange Sort of Bees *in the* Weſt-Indies. Phil. Tranſ. N° 172. p. 1030.

M. *De Villermont* had a ſort of honey-comb from the iſland *Cayenne* in *North America*, of a different make from the *European*; it conſiſted of ſmall bottles, or bladders of wax of a browniſh colour, inclining to black, as big as olives, and ſhaped like the *Spaniſh* olives; they hung together in cluſters, almoſt like a bunch of grapes, and were ſo contrived, that each of them had an aperture, during the work; which was cloſed up again, as ſoon as the veſſel of wax was filled with honey; and then the bees go to work with another veſſel: They ordinarily lodge in a hollow tree, or the cavity of a rock, by the ſea-ſide; theſe being the propereſt places to ſecure themſelves from ſuch animals, as are greedy of their honey, and therefore moſt likely to moleſt them; and they have the greater need of this precaution, becauſe they are more liable to be diſturbed than ordinary bees, as having no ſtings: When the combs are removed, they muſt be carried gently, and in the ſame poſition they lay in: The honey itſelf is as clear and liquid as rock-water, and hardly to be diſtinguiſhed from it by the ſight; when you would take it out, you muſt pierce every bottle with the thorn of a wild palm, or a pin, a little more than ⅓ from the bottom; for if you pierce it lower, there is a ſediment, whoſe thickneſs hinders its running: This honey is thought to be one of the moſt agreeable liquors in the world; if a quantity of a good glaſs, or half

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half a pint be drank faſting, it will give two or three ſtools, in about two hour's time, according to the conſtitution of the party; but if drank at meals, it does not purge at all: Ambergreaſe is ſuppoſed to be nothing elſe, but the wax mixed with the honey, which falls into the ſea, and is toſſed about in the waves, between the *Tropics*.

A Hygroſcope; *by Mr.* Will. Molyneux. Phil. Tranſ. N° 172. p. 1032.

AB, Fig. 8. Plate IX. is a whip-cord about four foot long, tied faſt to the end of a hook A; at the end of this whip-cord there hangs the weight C, about a pound or ſomething more; this weight is fitted at the end ſo as to receive and carry the index D; under theſe is placed a graduated circle on the board E F, fixed by a bracket againſt the wall: When all things are thus fitted; the moiſture of the air twiſts the rope, and gives a motion to the index over the diviſions in the graduated circle; and again, as the air grows drier, the cord untwiſts, and brings back, or reduces, the index by a contrary motion: What gave Mr. *Molyneux* the firſt hint of this, was his obſerving all ropes tied at both ends to be much more tight and harder ſtretched after rain had fallen upon them, than they were before; now he concluded, that if he could, as it were, tie a rope at both ends, and yet allow one end a power of circumvolution, it would produce the deſired effect; and the weight C hung at the rope ſeemed to do this; for it fixes, as it were, the end of the rope B, and yet permits it to twiſt and untwiſt; the reaſon of which is plain, for the little particles of moiſture, inſinuating and ſoaking into the cord, are like ſo many wedges, which muſt needs ſhorten the rope, as a bladder is ſhortened by being blown up, whereby it will raiſe a great weight; but the eaſieſt way for the rope A B to ſhorten, and raiſe up the weight C, is to do it as a ſcrew; for itſelf is one, its ſtrands being twiſted, and each thread therein, ſcrew-wiſe, conſequently the index muſt have a circular motion: To make an experiment of this, he wetted a cord, and hung it up with the weight at the end of it, and he perceived that as it dried, it untwiſted, and that too very quick, ſo as to be perceived by the eye; after the cord had ſo far untwiſted, as he thought it had come to that degree of dryneſs, that the preſent conſtitution of the air would permit, he took a baſon of warm water, which emitted a fume and ſteam, and placed it under the cord; immediately the cord began to twiſt again very quick, and ſo continued till the water ceaſed its ſteams, or was removed, and then immediately it began to untwiſt; he then gently breathed upon it, and he found, according to his expectation, that eight or ten breathings would twiſt it five degrees of a circle; after this, he expoſed it to the air only, and he found it to obey the alterations thereof very nicely; not the leaſt ſhower falling, at which it did not preſently twiſt; and when by riſing clouds a fair day became overcaſt, the cord was immediately ſenſible thereof, and again as ſenſible of their vaniſhing, and of the change to fair ſun-ſhine; ſo that it ſeems to be the niceſt hygroſcope hitherto uſed: One of the grand defects of moſt hygrometers is, that they grow weak with age, and do not ſo nicely obey the alterations of the air, when long kept, as when firſt made; but whether the preſent invention be ſubject to the ſame fault, time muſt determine: The alterations alſo of the air, may give this kind of hygroſcope more than one turn; now this being inconvenient, and the duplication of the turn hard to be regiſtred, as Mr. *Hook* propoſes in his micrography, concerning the beard of a wild oat: To remedy this, the point A, as being fixt, has no turn or motion, therefore the middle point G hath but one turn, and the index D placed there will have but one turn; and what is here ſaid of two turns, and the middle point G, may be accommodated to any other number of turns and parts, or points in the rope.

The Scotiſh Barnacle *and* French Macreuſe, *with an Account of burning* Fountains; *by Dr.* Tancred Robinſon. Phil. Tranſ. N° 172. p. 1036.

THERE are ſo many miſtakes amongſt naturaliſts, and ſome learned men, concerning the bird called *Macreuſe* at *Paris*, and in other parts of *France*, *Macroul*, or *Diable de Mer*, that the ſubject may ſeem worth the enquiring into: The *French* eat it upon fiſh-days, and during all *Lent*, taking it for a ſort of fiſh, or a ſea animal with cold blood, or elſe a *Barnacle* generated either from rotten wood floating on the ſea, or from certain fruits falling into the water, and there transformed into a bird, or elſe from a kind of ſea-ſhells adhering to old planks, and bottoms of ſhips, called *Conchæ Anatiferæ*; whereas a *Barnacle*, as alſo the *Macreuſe* itſelf, is oviparous, and of the gooſe kind; and the ſhells themſelves contain a teſtaceous animal of their own ſpecies, as the oyſter, cockle, and muſcle do: *Geſner* was led into the firſt error by *Gyraldus*, *Boethius*, and *Turner*; Sir *Robert Moray* fell into the third and laſt

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laſt miſtake; Sir *Robert Sibbald* and M. *Graindorge* have, it is true, confuted theſe equivocal generations of the *Barnacle* and *Macreuſe*; yet they both make them to be the ſame bird; whereas they are of different ſpecies; the *Barnacle* being of the gooſe, and the *Macreuſe* of the duck-kind: That the *Barnacle* and *Macreuſe* are both of them oviparous, is beyond all doubt; the anatomy of their parts ſerving for generation, their laying eggs, and ſometimes breeding amongſt us, are all evident proofs thereof: M. *Cattier* in his *Traité de la Macreuſe* affirms the *French Macreuſe* to be the greater *Coot* of *Bellonius*, and Mr. *Willoughby* ſeems to be of the ſame opinion in his *Ornitholog.* p. 320; ſome learned men take it for the *Puffin* of the *Sillies* and *Iſle of Man*; others take it for a ſort of ducker or diver; but the *French Macreuſe* is of the duck-kind, and is the *Scoter*, or *Anas Niger Minor* deſcribed by Mr. *Ray*; it is frequently taken in nets placed under water, on the coaſts of *Normandy*, *Languedoc* and *Provence*; and in great numbers at the mouth of the *Seine*; and Dr. *Robinſon* had ſeen it on the *Laguna* of *Venice*, at the mouths of the *Brenta*, *Addeſis* and the *Po*, as alſo on the *Mare Mortuum* and the lake *Avernus*, where he obſerved many other water-fowl feeding upon, and flying over that water, ſaid by many to kill birds at a diſtance; and ſeveral land-fowls were obſerved to fly over that lake without the leaſt diſorder; but perhaps the poiſonous ſteams, if there are any peculiar to that lake, ſometimes vaniſh and return again, or elſe they may be altered by new effluvia intermingled with them.

The burning fountains near *Grenoble* in *Dauphine*, *Hermanſtadt* in *Tranſylvania*, *Chermay* a village in *Switzerland* in the Canton of *Triburg*, and that not far from *Cracow* in *Poland*, do agree in many particulars with that near *Wigan* in *Lancaſhire*; as in being actually cold, yet inflammable and taking fire at a diſtance, upon the application of any lighted body; which the boiling ſprings near *Peroul* will not do; but this is to be underſtood of them in their ſources, becauſe when removed from thence, neither the waters nor their earths will produce any ſuch phænomena, as boiling or flaming: It is affirmed of the burning fountain in the palatinate of *Cracow*, that upon evaporating the water a dark or pitch-like ſubſtance may be extracted, which cures the moſt inveterate ulcers in a ſhort time; and that the mud itſelf is very powerful againſt rheumatic and gouty pains, palſies, ſcabs, &c. The inhabitants of an adjacent village, drinking much of this ſpring, do generally live to 100 or 150 years, which is attributed to the ſanative virtue of the water.

Of the incombuſtible Cloth; *by Dr.* Rob. Plot. Phil. Tranſ. N° 172. p. 1051.

THE incombuſtible linnen was greatly eſteemed by the ancients, amongſt whom it was more common and better known than it is now; nor is it at this day of ſmall value in the country where it is made, a *Chineſe* cover, which is a piece 23 ¾ inches long, being worth 80 tale, that is, 36 *l.* 13 *s.* 4 *d:* The reality of ſuch a thing has been either doubted or denied by very good authors; who, tho' they owned ſuch a mineral as *Amianthus*, out of whoſe wooly part, this ſort of linnen was always anciently ſaid to be made, yet queſtioned the poſſibility of its having actually been done; *Dalecampius* holding it very incredible, that it ſhould be woven into cloth, by reaſon of its ſhortneſs, and *Schildius* in his commentary on *Suetonius* abſolutely denying it: It is true *Boxhornius* does not deny but that there might be ſuch linnen amongſt the *Indians*, where its materials grow, of which they might make funeral ſhrouds for the bodies of their princes, and ſo preſerve their aſhes diſtinct from thoſe of the funeral pile in which they were burnt; but whether the *Romans* ever uſed it or not, Dr. *Plot* pretends not to diſpute, only it is certain they might, had they ſo pleaſed; for *Pliny* ſays expreſsly, that he himſelf had ſeen napkins thereof, which, taken foul from the table at a great feaſt, were caſt into the fire, by which means they were better ſcoured and looked fairer and clearer than if they had been waſhed in water; now if they had ſuch napkins, they might doubtleſs have had ſheets of it too, and have put them to the uſe abovementioned, had they thought it expedient, as it is ſaid the *Tartarian* princes and others do at this very day: That this linnen was very well known to the ancients, we have beſides the teſtimony of *Pliny*, that of *Cœlius Rhodiginus*, who places both the materials and manufacture of it in *India*; and *Paulus Venetus* mentions it to be more particularly in *Tartary*, the emperor of which, he ſays, ſent a piece of it to *Pope Alexander*; it is alſo mentioned by *Varro*, and *Turnebus*, in his commentary upon him *de Lingua Latina*, as a thing not to be conſumed by fire; *Geo. Agricola* relates that there was a mantle of this linnen at *Vereburg* in *Saxony*, and *Simon Majolus de Dieb. Canicul.* Part. 1. Colloq. 20, ſays, he ſaw another of it at *Louvain* expoſed to the fire; *Salmuth* alſo acquaints us, that one *Podocattarus* a *Cyprian* knight ſhewed it publickly at *Venice*, throwing it into the fire without ſuſtaining any hurt; and Mr. *Laſtels* in his voyage to *Italy*, ſaw a piece of it in the curious cabinet of *Manfred Septella*, canon of *Milan*; Mr. *Ray* was ſhewn a purſe of it by the prince *Palatine* at *Heidelberg*, which he ſaw put into a pan of burning charcoal, till it was red hot without receiving any damage; and beſides theſe teſtimonies, a piece of this linnen was made to paſs the fire both at *London* and *Oxford*.

This lanuginous mineral hath ſeveral names, as, 1. *Amianthus*, becauſe it is ſo far from being ſpoiled in the fire, that it rather acquires a new luſtre. 2. *Asbeſtos*, that is, unextinguiſhable. 3. *Salamandra* or ſalamander's wool; from the candle-wicks ſaid to be made anciently of it. 4. From a pungent quality, which, according to *Agricola* it has on the tongue without any aſtringency, it is otherwiſe called *Alumen*, with the diſtinguiſhing epithet *Plumeum*, taken from its downy filaments, to diſtinguiſh it from the other alums. 5. From the light grey colour of its lanuginous parts, it is called by ſome *Polia*, by others *Corſoides*, and from its likeneſs to the hoary fibres of ſome ſort of matweed, *Spartapolia*. 6. From its aptneſs to be ſpun into thread, it is alſo called *Linum*, or flax, with ſome diſtinguiſhing epithet, taken either from its quality, ſuch as *Asbeſtinum* or *Vivum*, or from the place where it is found, it being called in general *Linum Foſſile*, earth-flax, and in particular, *Linum Indicum*, *Creticum*, *Cypricum*, *Carpaſium* and *Caryſtium*: But beſides the places, whence it borrows names, it is alſo found in *Tartary*, at *Namur*, in the *Low Countries*, at *Eisfield* in *Thuringia*, amongſt the mines in the old *Noricum*, alſo in *Egypt*, and in the mountains of *Arcadia*, at *Puteoli* and in ſome mines of *Italy*; it has likewiſe been found in a ſmall iſland, called *Ynis Molroniad* in the pariſh of *Llan-Fairyng Hornwy* in *Angleſea* in *Wales*.

Naturaliſts commonly reckon it among the ſtones, but Dr. *Plot* judges it to be rather a *Terra Lapidoſa*, or a middle ſubſtance between ſtone and earth; but whether the one or the other, it probably conſiſts of a mixture of ſome ſalt or other, and a pure earth without ſulphur, coagulated in the winter, and hardened to maturity by the ſummer heats; which ſalt *John Heſſus* proves by a very cogent argument to be *Alumen Liquidum*, deſcribing it, as *Matthiolus* alſo does, to be of a whitiſh milky ſubſtance, ſomewhat inclining to yellow, that ſweats out of the earth, and ſmells like rotten cheeſe; of which having gathered a quantity at *Puteoli*, together with the other ſpecies of alum, and kept it a while by him, when he came to look on it again, he found it to have loſt the ſmell, and a great part of it to be changed into *Alumen Plumeum*; the ſaline part did probably ſhoot into threads, and the pure earth united them, as they are found in the places where generated, whether we ſuppoſe it to exſudate or ſweat from the earth, as *Pliny* and *Mathiolus* would have it, or to be percolated thro' rocks, as it is found in *Wales*, its veins there running thro' a rock of ſtone, in hardneſs and colour not unlike flint: And yet it ſeems to be made of much ſuch an alum as that of *John Heſſus* at *Puteoli* was, ſome of it being ſtraw-coloured, as if it ſtill retained the yellowneſs that his liquid bitumen was ſaid to have; which is a colour not aſſigned it by any author, moſt of it being ſaid to be white or cineritious; ſome of it red, and ſome of an iron-colour, according to *Agricola*; and Dr. *Plot* had ſome of the *Cyprian*, part of which was of a light blue or pearl-colour, and the other part had a caſt of ſea-green: But however the whole mineral ſubſtance, found at ſeveral places, may differ in colour, yet Dr. *Plot* found the wooly part to be much the ſame; *viz.* of a white ſilver-colour, the threads very fine and ſlender, yet very ponderous, the ſmalleſt particles of them when thoroughly wet ſinking in water; whence it is probable, that it is not a vegetable, but a mineral ſubſtance, tho' it is known that ſeveral woods as box-wood, red-wood, *Perſian* wood, *&c.* will ſink in water.

Marcus Paulus Venetus acquaints us, that it is found in *Tartary*, in a certain mountain in the province of *Chinchinthalas*, and made into cloth, as he was informed by one *Curficar* a *Turk*, ſuperintendent of the mines in that country, in this manner; the lanuginous mineral or *Amianthus*, being firſt dried in the ſun, is then pounded in a braſs mortar, and the earthy part ſeparated from the wooly, which is afterwards waſhed from any impurities that may ſtick to it, being thus purged, it is ſpun into thread like other wool, and after wove into cloth; which, when foul or ſpotted, they cleanſe by throwing it into the fire for an hour's time, whence it comes out unhurt, as white as ſnow; which very method, according to *Strabo*'s account, ſeems alſo to have been uſed in ordering the *Cretan Amianthus*; with this addition, that after it was pounded, and the earthy part ſeparated from the wooly, he ſays, it was combed, which is alſo affirmed by *Agricola*; an argument there was ſome of a greater length; but whatever truth is in this, it is certain that the *Cyprian* is ſhort enough, as alſo the *Welſh*, and what was known of it in *Pliny*'s time, who confeſſes that it was hard to weave by reaſon of its ſhortneſs.

According to the teſtimony of *Pliny*, ſhrouds of this linnen were anciently uſed at the royal obſequies of kings, wherein their bodies were burnt, in order to preſerve their aſhes entire, and prevent their being mixed with thoſe of the wood, whereof the funeral piles conſiſted; and the princes of *Tartary* do uſe it at this day for burning their dead; and tho' it diminiſhes every time, it undergoes the violence of the fire, yet this hinders not, but it may do that ſervice ſeveral times, before it be rendred altogether uſeleſs: *Cælius Calcagnanus* ſays, that ſome of the ancients made themſelves cloaths of it, with whom *Turnebus* agrees, in his commentary on *Varro*; and *Cælius Rhodiginus* relates that the *Indians* made garments of it, but *Hierocles* reſtrains it to the *Brachmans* only: The wicks for the perpetual lamps of the ancients were alſo made of it: *Marco Antonio Caſtagna*, who had found this mineral in *Italy*, had the art of preparing and rendring it ſoft and tractable, and of making it thick or thin to any degree at pleaſure, ſo that it would reſemble a very white ſkin, or very white paper: There was at *Oxford* paper made of the *Welſh Amianthus*, which would both bear fire and ink well enough, the ink only turning red by the violence of the fire.

In order to ſhew the reaſon whence it is, that this ſubſtance ſhould be ſo ſtrangely privileged by nature, we muſt conſider, that the qualities and power of the fire, according to *Ariſtotle*, are, to ſeparate things of a different and unite thoſe of a like nature; whence it is obſerved that the ſubjects moſt apt to take fire, and be diſſolved by it, are ſuch heterogeneous bodies, in whoſe pores the moſt ſulphureous, bituminous and aqueous particles are lodged; which being ſeized on by the fire, are quickly put into motion, dilated and ſeparated; and being thus made capable of flying away, they are at laſt conſumed, and the frame of thoſe bodies is diſſolved, whoſe parts were before united by them; when theſe are fled, the fire naturally goes out, as having nothing now left to work upon, except the ſalts and earth in form of aſhes, which, in all compounds do reſiſt this element moſt, and will remain after the moſt exalted operation it can be forced to; nor do the ſalts only of mixt bodies thus baffle the force of the fire; but the ſimple ones much more, as being more homogeneous; as is ſeen in the decrepitation of common ſalt, and exſiccation of vitriol, which, when the aqueous parts are once evaporated, are now a pure ſimple homogeneous body, no longer ſenſible of the fire, the decrepitation ceaſing, and nothing remaining, that can be dilated farther, to break the corns of ſalt; now whatever the fire cannot dilate, it cannot ſeparate, nor conſequently deſtroy, or take any thing from it, except what is heterogeneous, and accidentally adhering to its outſide; which is perfectly the caſe of our incombuſtible linnen, whoſe threads being altogether homogeneous, and nothing elſe but the pure *Striæ* of liquid alum, holding nothing of ſulphur, bitumen or water, or any thing that is different or heterogeneous to itſelf, that can be dilated or ſeparated, it is in no poſſibility of being liable to the fire, which may indeed paſs thro' it, as we ſee it does when made red hot, but can carry nothing from it.

The Diſſection of a Lady *who died of an* Apoplexy; *by Dr.* Will. Cole. Phil. Tranſ. N° 173. p. 1068. *Tranſlated from the* Latin.

A Certain lady had been for ſeveral years afflicted with hypochondriacal, or as they are popularly called, hyſteric ſymptoms, which were ſometimes attended with a *Hæmorrhagy* at the noſtrils, at times ſo copious as to endanger her life; the day before ſhe died, ſhe was threatned therewith, and to prevent the danger ſhe apprehended, ſhe uſed remedies that were too fatally ſucceſsful; for tho' ſhe did not bleed at the noſe, yet after ſhe went to bed that evening, ſhe was ſuddenly ſeized with a prodigious head-ach, and before a ſurgeon could be had to breathe a vein, ſhe died in half an hour after the fit.

Upon opening her, there was not the leaſt ſign of obſtruction in the liver, only it was ſomething large, cauſing a more than ordinary tenſion in the *Hypochondrium*; there was no gall either in the gall-bladder, which was very much contracted, or in the biliary veſſels in the liver; only in the bladder there were found fourteen concretions, moſt of which were in bulk equal to a pea, two or three were a little larger, of a flat round, externally black and ſmooth, and after being a little expoſed to the air, they reſembled *Bezoar*; at firſt view they appeared like aloetic pills; they were internally yellowiſh, and eaſily friable, with ſomething of a cavity in the middle: The ſpleen in like manner appeared ſound, but, like the liver, it was larger than ordinary; the *Pancreas* gave no ſigns of obſtructions; the kidneys were free both of gravel and ſtone, tho' the patient had ſome ſuſpicion of them from a pain in that region; the *Uterus* was in a natural ſtate, tho' the ſymptoms, under which ſhe laboured, are uſually aſcribed to that *Viſcus*: On the right ſide, for four fingers breadth, the lungs firmly adhered to the *Pleura*; and they were in ſeveral places, eſpecially here and there about the edges of the lobes, ſo black, that they ſeemed to tend to a mortification: The heart was ſound; and what is remarkable, its baſe was furniſhed with a great quantity of fat, tho' the reſt of her body was much emaciated: Upon opening the ſcull, the blood veſſels, which creep over the *Meninges*, eſpecially the *Pia Mater*, of the right lobe of the brain were very turgid; upon cutting thoſe veſſels of that ſide of the brain, where the patient felt her pain, there iſſued out a great quantity of ſerous blood, after draining which, and opening up the ſubſtance of the brain, there appeared a large concretion of grumous blood, weighing nearly an ounce and a half; but there was no effuſion of blood either into the ventricles, or any where elſe between the membranes; neither was the left lobe or its veſſels very turgid: Both the *Cerebrum* and *Cerebellum* after they had been taken out of the ſcull and freed, as much as poſſible, of ſuperfluous blood weighed 2 pounds and 14 ounces averdupois.

Experiments for trying the Force of great Guns; *by Mr.* Greaves. Phil. Tranſ. N° 173. p. 1090.

AT 200 yards diſtance from the platform for great ordnance at *Woolwich*, there were three butts raiſed, one behind the other; the ſpace between the firſt and ſecond butt was 14 yards; between the ſecond and third, eight; the thickneſs of each butt was 19 inches; whereof 13 were of beams of maſſy oak faſtened in the ground, and ſet ſo cloſe, that they touched each other; on each ſide there were planks of oak, each three inches thick, and theſe were joined cloſe, and faſtened on both ſides with iron bolts, and ſtrong wooden pins; and on the back, at the ends and middle there were three braces of elm, a foot in breadth, and five inches thick.

The firſt experiment was made with an iron demi-cannon, having a cylinder-bore of 3500 *lib.* weight, the bullet 32 pounds of iron, the powder 10 pounds, which pierced the two firſt butts, and ſtuck in the third, ſo as that the ball was almoſt quite within, but the timber was neither ſhivered, nor ſcarce ſplit, and the butts did not feel warm; it produced the like effect, when charged with 9 *lib.* as alſo, when with 8 *lib.* of powder: The ſecond experiment was with an iron demi-cannon, having a taper bore, and being 3600 *lib* in weight, and four inches longer than the former; the iron bullet was 32 *lib.* and the powder 7 *lib.* which in three trials ſeemed to have the ſame force with the firſt: One of the ſhots, piercing the ſecond butt, and lighting near the edge of the middle brace of elm, tore it, but by its yielding, the bullet glanced aſide off the third butt, and entred into the earth: The third experiment was with a whole culverin in braſs of 3530 *lib.* in weight, 11 foot 1 inch in length, with a taper bore; the iron bullet was 18 pound in weight; the powder in the firſt trial was 10 *lib.* in the ſecond 9, in the third 8, which laſt proportion did the beſt execution, and paſſed thro' the two firſt butts, entring gently into the third, which the former two only touched: The fourth experiment was made with a whole culverin in braſs, with this mark 3580, being 10 foot long, and not very thick in the breech; the firſt ſhot with 9 *lib.* of powder, 18 *lib.* of iron bullet, paſſed thro' the three butts, and entered one foot into the ground; it paſſed by the joints of the timber, two planks being beat down before; the ſecond ſhot with 8 *lib.* powder paſſed thro' two butts, and grazed between them; the third with 8 *lib.* paſſed two butts and ſeven inches into the third; but the firſt butt was much battered before, where it entred; the fourth ſhot paſſed with 8 *lib.* powder, two butts, and in both butts thro' the middle of a maſſy ſtrong beam, below, that had not been battered: The fifth experiment was with an iron demi-culverin having 9 *lib.* bullet in iron, and 4 *lib.* powder; this paſſed one butt, which was not torn before, and entred the ſecond: This demi-culverin was ſhot eight times, as faſt as it could be charged with powder and the iron bullet, and yet it was but ſcarcely lukewarm at the breech, a little more than ſo in the middle, and warmeſt at the muzzle, which yet was ſcarcely ſo hot as one's hand: The ſixth experiment was with a braſs demi-culverin, whoſe breech was 13 $\frac{7}{8}$ inches and mouth 9 $\frac{5}{8}$ by a calliper-compaſſes; the firſt ſhot, with 4 *lib.* powder, 9 *lib.* iron-bullet, paſſed 2 butts; the ſecond ſhot, with 3 *lib.* powder, paſſed almoſt 2 butts; this proved to be the beſt ſhot, becauſe the timbers were the ſtrongeſt.

An Account of Lough-neagh; *by Mr.* Edw. Smith. Phil. Tranſ. N° 174. p. 1108.

MR. *Smith* affirms, that no experiment or obſervation, yet made, can prove that this *Lough* hath really the quality of petrifying wood, or that its water doth in any manner promote the petrification; on the contrary, he was credibly informed, that two holly ſtakes, a wood that all agree will ſooneſt petrify in this *Lough*, had been ſtuck for 19 years in two ſeveral places of the *Lough*; and yet that part of the ſtake, which for ſo long a time had been waſhed by the water, remained without any petrification, or the leaſt advances towards it: It is ſaid indeed, that the water hath this virtue, eſpecially about thoſe places, where the *Black Water* diſcharges itſelf into the lake; but it ſeems evident from the very nature of liquid bodies, that any virtue received in one part muſt neceſſarily be diffuſed thro' the whole, at leaſt in ſome degree; and therefore there is good reaſon to believe, that the water is wholly deſtitute of this petrifying quality: But that this virtue is certainly, if not only, in the ground or ſoil, Mr. *Smith* judges from theſe reaſons; *viz.* that there are many ſtones turned up daily, eſpecially at the breaking up of new ground, which cannot probably be thought to be carried thither; they are often found in great numbers at two miles diſtance from the *Lough*, ſeldom farther, and very deep in the ground; and he was credibly informed, that a ſtump of a tree, dug out of the ground at a ſmall diſtance from the *Lough*, was found to be petrified; the roots and all were ſtone, entirely reſembling thoſe ſtones, that are ordinarily found, and go by the name of *Lough-neagh* ſtones; and that theſe ſtones were once wood, is very certain; for they burn, cleave, and cut with a knife, tho' not ſo eaſily as other wood; and filings of this ſtone thrown into the fire, emit a fragrant ſmell: It is obſerved, that not only holly, but alſo oak, and ſome other wood, has been petrified about this *Lough*, and in the adjacent ſoil; becauſe ſome fiſhermen had found buried, in the mud of this *Lough*, great trees with their roots and branches petrified, and ſome of that bigneſs, that they could ſcarcely be drawn by a team of oxen; and from their bulk they were thought to be oak, no trees in that country, theſe excepted, growing to that prodigious bigneſs; at leaſt, it is certain, that holly never does: The bark is never found petrified, but often ſomewhat rotten about the ſtone.

A periodical Convulſion; *by Dr.* Will. Cole. Phil. Tranſ. N° 147. p. 1113. *Tranſlated from the* Latin.

A Lady of wit and beauty, who applied herſelf very cloſely to her domeſtic affairs, had enjoyed a ſound ſtate of health for ſeveral years, tho' ſhe had been the mother of many children; but at laſt, about the middle of her pregnancy, ſhe fell into hyſteric fits, which, tho' then yielding to medicines, recurred at times, tho' not with that frequency; being near her time, ſhe happened, on ſome extraordinary occaſion, to ſtir about more than was fitting; next day her pangs, which were poſſibly haſtened, came on, with a great flux of blood, and without any appearance of a *Fœtus*; till, her ſtrength being exhauſted by the loſs of a great deal of blood, the aſſiſtants began to deſpair of her life; but reviving again, and being delivered of a dead child, in a little time ſhe fell into convulſions, which, in ſpite of all the medicines that were uſed, obſtinately afflicted her, tho' at intervals, for ſeveral months; afterwards ſhe became a little better, tho' not entirely freed from the abovementioned ſymptoms; which, at length encreaſing, did not, as formerly, ſeize her in uncertain fits; but attacked her, firſt, in tertian, then quartan, and not long after that, in quintan periods, that is, in which four entire days intervened between the beginning of each paroxiſm, and that with the greateſt exactneſs poſſible: The fits came on with yawning, ſhuddering, and a great diſcharge of limpid urine; whilſt the patient was in theſe convulſions, the aſſiſtants were obliged to lay hold of her hands, elſe ſhe would tear her face and cloaths, and deprived both of ſenſe and ſpeech, ſhe would attempt to bite the hands of the by-ſtanders; after continuing in theſe convulſions for an hour or two, and after a plentiful diſcharge at ſeveral times of limpid urine, the paroxyſm would vaniſh by degrees, and ſhe would fall a-ſleep, and that for many hours, and at laſt come to herſelf again, without being ſenſible of what paſſed; for the three other days, tho' freed from the fit, ſhe would be ſo very weak, that ſhe could ſcarcely riſe or walk without help: The cure was attempted with the teſtaceous powders and ſpirit of hartſhorn, the indication being taken from that profuſion of urine, and the affections of the nervous ſyſtem; which argued, that a conſiderable *Acor* was communicated to the blood and nervous juice; but the paroxyſms continuing obſtinate, notwithſtanding theſe medicines, and returning regularly, Dr. *Cole* bethought himſelf of treating them in the ſame manner as thoſe of intermitting fevers, ſince the periods were ſo regular, tho' they had not that degree of heat which commonly accompanies the latter; beſides, tho' all intermitting fevers, properly ſo called, have not the ſame degree of heat, yet they may all be cured by the bark; he reſolved therefore to make uſe of this famed ſpecific, at intervals exhibiting alſo the above-mentioned medicines; and the event was, that after adminiſtring two or three doſes of the bark before as many paroxyſms, the fits became ſenſibly milder, and by continuing the uſe thereof they entirely vaniſhed, and never after recurred.

Another periodical Convulſion; *by Dr.* Will. Cole. Phil. Tranſ. N° 174. p. 1115. *Tranſlated from the* Latin.

D*orothy Cook*, a widow of 60 years of age, who kept a coffee-houſe at *Worceſter*, was for 30 years afflicted with epileptic fits, which firſt appeared the third day after ſhe was married; and tho' often recurring in the beginning of the diſeaſe, yet they obſerved no regular period: The fit would come ſo ſuddenly upon her, that tho' ſhe ſeemed to herſelf and others to be in perfect health, yet ſhe would be ſtruck down to the ground in a moment, and be deprived of her ſenſes; in which condition continuing for ſome minutes, as if ſhe were dead, and without any convulſions, ſhe would at length come to herſelf again: After ſome months, about new and full moon, the paroxyſms would ſeize her very often a day, and recurr after two or three days, and the reſt of the moon ſhe would be well in health: In a few months more, the fits, which formerly obſerved the period nearly of two weeks, would at length return twice a week, but at unequal intervals, *viz. Thurſday* and *Friday*: A little after ſhe was married, ſhe proved with child, and was delivered at the uſual time; but ſhortly after, the child died epileptic, as did alſo a ſecond: And tho', after this, ſhe bore ſeveral children of both ſexes, yet none of them had any of theſe fits: In this manner ſhe was afflicted for about three years, tho' ſhe had tried ſeveral medicines, till the paroxyſms at length diſappeared by means of ſome quack-preſcription, nor did they recurr again for ſome months; but by a fright, the diſeaſe, which was rather palliated than thoroughly removed, broke out a-new; after which ſhe had recourſe to the ſame remedy, but without ſucceſs; nevertheleſs ſhe was a ſecond time cured by Dr. *Johnſon*, and ſhe continued well in health till the famous battle at *Worceſter* in

1651, when *Cromwel* took the town, and death and horror raging every where, ſhe ſhared in the common conſternation; upon which her paroxyſms recurred again; being at firſt irregular and frequent, by degrees they returned to their old period; all the medicines preſcribed her proved ineffectual; after her fits had continued to recurr in this manner for two years, at length by a new fright they changed their period, firſt coming upon her twice a week, and at laſt on *Sunday* only ever after, in the following manner; *Thurſday* evening ſhe would begin to have a pain in the *Vertex*, with a throbbing pain about the region of the *Os Sacrum*, which, on *Friday* creeping up gradually higher, would poſſeſs the middle of the back; *Saturday* evening it would become more violent, and be accompanied with exceſſive thirſt; in a few hours after ſhe was gone to bed, it would encreaſe and aſcend to the ſhoulders, and then ſhe durſt not ſo much as ſtir her body, elſe ſhe would be in danger of bringing a more ſevere fit upon her, and that ſome hours before its wonted time; this evening, on account of her exceſſive head-ach ſhe could ſleep but little, and in the morning the pain would change to a diſorderly drowſineſs, on which account ſhe would be obliged to keep her bed all *Sunday*; it is true ſhe ſlept in the morning, but her ſleep was broken, and ſometimes waking ſhe would call for drink, after which ſhe would fall a-ſleep again; about 12 o'clock, if ſhe did not wake of herſelf, ſhe would be waked by the by-ſtanders, and made to take meat; hitherto ſhe would be perfectly ſenſible of what paſſed; after this, falling immediately a-ſleep; unleſs you rather chuſe to call it a *Torpor* or numbneſs; for ſhe could neither be waked, nor was ſhe ſenſible of any thing; and frequently toſſing her body a-bed, ſhe would continue in this condition till about ſix in the evening; then ſhe would be ſeized with intermitting convulſions for five hours, at firſt more gentle, till about 11 o'clock, when they became very violent; in the intervals of which ſhe would greedily ſwallow ale; for, when in her ſenſes, ſhe would diſcharge thoſe about her to give her any ſmall drink in the fit, becauſe ſhe complained that it affected her ſtomach; after eleven ſhe would recover the uſe of her ſenſes, but paſs the remaining part of the night in reſtleſs toſſings; *Monday* morning about 9 o'clock ſhe would get up, but all the day complain of aches over her whole body; and tho' ſhe could with freedom enough go up and down the houſe, and ſerve her cuſtomers with coffee, yet ſhe would complain of a ſtiffneſs in her joints, and an unfitneſs for motion; which notwithſtanding would wear off by the gentle ſlumbers of the enſuing night, yet without any ſenſible or critical evacuation by ſweat, urine, or any other way; and after a reſpite of two or three days the ſame ſymptoms would return: She had for a long time entertained a fancy, that if ſhe ſtirred abroad her fits would immediately come upon her; which accordingly happened, upon her being invited to ſup at a neighbour's houſe, for the paroxyſm came before its uſual period, and proved very ſevere: The famous ſtroaker *Greatrix*, being at *Worceſter*, was brought to her to try what ſtroaking could effect in ſo uncommon a caſe; of which, when ſhe was appriſed, without ſo much as ſeeing him, ſhe fell into a very violent fit, which continued for ſeven days: In a courſe of many years illneſs, her intellectuals and other animal functions were not ſenſibly affected, but ſhe diſpatched her family affairs, with as much dexterity, conſidering her age, as if ſhe had been in perfect health; and ſhe was in a very good plight of body, and of a florid complexion.

The Cauſe of Winds, *and of the Change of* Weather; *by Dr.* Geo. Garden. Phil. Tranſ. N° 175. p. 1148.

THERE are continual eaſterly winds under the *Line*, which they call breezes; therefore the *Spaniards*, in going to the *Weſt-Indies* ſail ſouthward from *Spain*, along the coaſt of *Africa*, till they are beyond the tropic of *Cancer*, within 20 degrees of the *Line*, where they generally meet with an eaſterly wind, and then they ſail on weſtward with a full wind, without ſhifting their ſails in the whole voyage; and this they give as the reaſon, why the voyage from *Spain* to the *Weſt-Indies* is ſhorter, eaſier, and more certain, than that homewards; in the *South-Sea* alſo, going from *New-Spain* or *Peru* to the *Philippines*, or *China*, the voyage is eaſy, ſailing always from eaſt to weſt near the *Line*, where the eaſterly winds blow right a-ſtern: *Acoſta* relates, that in the year 1584, there went a ſhip from *Calloa* in *Lima* to the *Philippines*, which ſailed 2700 leagues, with a conſtant breeze, out of ſight of land; and that in two months time, their courſe being almoſt under the *Line*: Now, theſe continual eaſterly winds between the tropics, Dr. *Garden* ſuppoſes to proceed both from the earth's motion, and the vertical influence of the ſun, in this manner; as the vaſt fluid and *Æther*, wherein the earth floats in its annual motion, moves forwards with the earth in that motion, or rather carries the globe of the earth along with it; juſt ſo the atmoſphere, and a large vortex o *Æther*, beyond the moon, goes round with the earth in it diurnal motion, which tho', according to its diſtance from the earth, it may be proportionably ſlower in its motion, yet that portion of the atmoſphere, which is neareſt the earth, and ſurrounds it, may be ſuppoſed to keep equal pace with the earth in its motion; and if there were no changes in the atmoſphere's gravity, it would always go along with the globe of the earth, from weſt to eaſt, in an uniform motion, which would be wholly inſenſible to us; but that portion of the atmoſphere, under the *Line*, being extremely rarified, its ſpring expanded, and ſo its gravity and preſſure much leſs than that of the neighbouring parts of the atmoſphere, and conſequently uncapable of the uniform motion to the eaſt, it muſt needs be preſſed weſtwards, and make that continual breeze from eaſt to weſt between the *Tropics:* On this ſide the *Tropic*, about 28 or 30 degrees, there are to be found conſtant weſterly winds; and therefore the *Spaniſh* fleets from the *Weſt-Indies* do not return the ſame way they went, but both from *Peru* and *New-Spain* they ſail along the coaſt northwards, till they touch at the *Havanna* in *Cuba*, and rendevouzing there, they ſail ſtill higher without the *Tropics*, where immediately they meet with weſterly winds, which ſerve them till they come in view of the *Azores*, and from thence to *Seville:* In like manner in the *South-Sea*, they who return from the *Philippines*, or *China* to *Mexico*, in order to have the weſtern winds, ſail up a great way, till they come right againſt the iſlands of *Japan*, and diſcovering *California*, they return by the coaſt of *New-Spain* to the port of *Acapulco*, from whence they ſet ſail; ſo that tho' they ſail eaſily from eaſt to weſt in both ſeas within the *Tropics*, becauſe the eaſterly winds are more conſtant there, yet returning from weſt to eaſt they muſt ſeek the weſterly winds without the *Tropics*, in the latitude of 27 degrees. Now the reaſon of this ſeems clearly deducible from the former; for the preſſure of the air between the *Tropics* being continually leſs than that of the neighbouring parts of the atmoſphere, and ſo conſequently by them preſſed weſtwards, its motion from weſt to eaſt is proportionably encreaſed beyond that uniform motion it would have, if the whole atmoſphere were equally denſe, and conſequently there will blow a conſtant wind from weſt to eaſt, for ſome degrees beyond the *Tropics:* The eaſterly winds between the *Tropics*, by what appears from eaſtern voyages do not blow conſtantly from the ſame point, nor directly from the eaſt; but for one half of the year, *viz.* from *April* to *November*, or thereabouts, they come from the ſouth-eaſt, and for the other half of the year, *viz.* from *November* to *April*, they blow from the north-eaſt; and theſe are called the *Monſoons*, or trade-winds; hence it is, that they who ſail from *China*, *Japan*, &c. to *Bantam*, muſt wait the northerly *Monſoon*, which falls between *November* and *April*; and thoſe who return from *Bantam*, muſt go back again, when the ſoutherly *Monſoon* comes, which is between *April* and *November*; and the currents of the ſeas are ſaid to obſerve the ſame motions and changes with the winds: Now theſe *Monſoons* may be eaſily accounted for from what has already been ſaid about the cauſe of the continual eaſterly winds between the *Tropics*; for ſince the diminution of the preſſure of the air under the *Line*, and that of the neighbouring parts of the atmoſphere cauſe theſe continual breezes, if the ſun were conſtantly in the equinoctial, it is probable the wind would always blow directly from the eaſt; but as he is one half of the year on one ſide of the *Line*, and the other half on the other, there muſt neceſſarily follow a change of theſe breezes into ſtated *Monſoons*; for if we imagine the atmoſphere to be divided into two equal hemiſpheres, by the equinoctial plane, and if the ſun were always in that plane, there would be conſtantly an equal preſſure from both theſe hemiſpheres on the air under the *Line*, the breeze would be directly from the eaſt; but when the ſun comes to be on the north ſide of the *Line*, as far as the *Tropic* of *Cancer*, and back again, there is not an equal balance, but the preſſure of the ſouthern hemiſphere of the air muſt needs be greateſt, and conſequently the breeze muſt blow all that ſeaſon from the ſouth-eaſt; and when the ſun returns again to the ſouthward of the *Line*, as far as *Capricorn*, and back again, the preſſure of the northern hemiſphere muſt neceſſarily preponderate, and make the wind blow all that half year from the north-eaſt; and this ſeems to agree very well with experience; for their northern *Monſoons* are in our winter ſeaſon, when the ſun is in the ſouthern ſigns; and their ſouthern ones in our ſummer, when he is in the northern ſigns: The rivers of *Indus* and *Ganges*, where they enter the ocean, do contain between them a large *Peninſula*, which is divided in the middle by a ridge of high hills, called the *Gatæ*, which run along from eaſt to weſt, quite to cape *Comorin*; on the one ſide is *Malabar*, and on the other *Coromandel*; on the *Malabar* ſide, between that ridge of mountains and the ſea, it is ſummer from *September* to *April*; in all which time there is always a clear ſky, without once raining, or at leaſt very little; on the other ſide the hills on the coaſt of *Coromandel*, it is at the ſame time their winter, every day and night yielding abundance of rain; and from *April* to *September*, it is on the *Malabar* ſide their winter, and on the other ſide their ſummer; ſo that in little more than 20 leagues journey in ſome places, as where they croſs the hills to St. *Thomas*, on the one ſide of the hills you aſcend with a fair ſummer, on the other you deſcend with a ſtormy winter: The like is ſaid to happen at cape *Razalgate* in *Arabia*; and Dr. *Trapham* relates the ſame of *Jamaica*, intimating that there is a ridge of hills running from eaſt to weſt thro' the middle of the iſland, and that the plantations on the ſouth ſide of theſe hills have from *November* to *April*, a continual ſummer, whilſt thoſe on the north ſide have as conſtant a winter; and on the contrary, from *April* to *November*: From theſe and ſuch like accounts it ſeems evident, that a bare diminution of the gravity of the atmoſphere will not cauſe rain, but that there is alſo neceſſary, either a ſudden change of winds, or a ridge of hills to meet the current of the air and vapours, whereby the particles of the vapours may be driven together, and ſo fall down in rain; and hence it is, that whilſt the wind blows from the north-eaſt, *viz.* from *November* to *April*, there are continual rains in the northerly plantations of *Jamaica*, and on the coaſt of *Coromandel* in the *Eaſt-Indies*; becauſe the winds beat againſt that ſide of the hills, and ſo there is fair weather on the other ſide; there being no winds to accumulate the vapours in *Malabar*, and the ſoutherly plantations of *Jamaica*: But in the ſoutherly *Monſoon*; *viz.* from *April* to *November*; *Malabar* and the ſoutherly plantations of *Jamaica* have floods of rains, the wind beating againſt that ſide of the hills, whilſt in *Coromandel* and the other ſide of *Jamaica*, there is fair and clear weather: The maps make thoſe mountains of *Gatæ* run ſouth and north; and if ſo, the *Monſoons* muſt blow from other points, by reaſon of the neighbouring countries and iſlands, or elſe this is not the true cauſe of theſe ſeaſons: This alſo ſerves to clear up the peculiarity of ſeaſons in *Peru* beyond any other parts of the earth, and ſeems to be aſſigned by *Acoſta*, as the cauſe of it: *Peru* runs along from the *Line* ſouthwards about 1000 leagues; it is ſaid to be divided into three parts, long and narrow, called *Llanos*, *Sierras* and *Andes*; the *Llanos* or plains run along the *South-Sea* coaſt; the *Sierras* are all hills with ſome vallies; and the *Andes* are ſteep and craggy mountains; the *Llanos* are generally about 10 leagues in breadth, in ſome parts leſs and in others more; the *Sierras* are about 20 leagues in breadth; the *Andes* as much, and ſometimes more, ſometimes leſs; they run in length from north to ſouth, and in breadth from eaſt to weſt: Theſe parts of the world are ſaid to have theſe things remarkable: *viz.* 1. All along the coaſt in the *Llanos*, it blows continually with one only wind, which is ſouth and ſouth-weſt, contrary to that which uſually blows under the *Torrid Zone*. 2. It never rains, thunders, ſnows, nor hails in all this coaſt, tho' there falls ſometimes a ſmall dew. 3. Upon the *Andes* it rains almoſt continually, tho' it be at ſometimes more clear than at other times. 4. In the *Sierras*, which lie between both theſe extremes, it rains from *September* to *April*, but in the other ſeaſons it is clearer; which is when the ſun is fartheſt off, and the contrary when neareſt: Now the reaſon ſeems to be; the eaſterly breezes, which blow conſtantly under the *Line*, being ſtopped in their courſe by the *Sierras* and *Andes*, and yet the ſame breezes being to be found in the *South-Sea* beyond *Peru*, as appears by the eaſy voyages from *Peru* to the *Philippines*, a current of wind blows from the ſouth on the plains of *Peru* to ſupply the eaſterly breeze in the *South Sea*; and there being but one conſtant gale in theſe plains, and no contrary winds, nor hills to beat upon, this ſeems to be the reaſon why the vapours are never or very ſeldom driven together into rain; and the *Andes* being in many places perhaps as high as the vapours aſcend in the higheſt degree of the gravity of the atmoſphere, this may probably be the reaſon, why the eaſterly breeze beating conſtantly againſt theſe hills cauſe rains upon them at all ſeaſons of the year; and the *Sierras* being, it ſeems, lower than the *Andes*, therefore from *September* to *April*, when the ſun is neareſt, and ſo the gravity of the atmoſphere leſs, and the vapours lower, they are driven againſt the *Sierras* and form rain: The cauſes of thoſe particular, various, uncertain and inconſtant winds, which blow without the *Tropics*, and that moſt frequently in mountainous countries and more ſeldom in great plains, as *Poland*, cannot eaſily be conjectured; but thoſe general winds, which uſually fall out every where about the two equinoxes, ſeem to proceed from ſome general cauſe, and this Dr. *Garden* takes to be the change of the *Monſoons*, and trade-winds, about theſe times between the *Tropics*; for about theſe ſeaſons, there muſt be a change of the balance of the atmoſphere, which muſt produce ſtrong winds over all the earth.

The

The Collection of Secants, *and the true diviſion of the Meridian in the* Sea-chart; *by Dr.* Wallis. Phil. Tranſ. N° 176. p. 1193.

TO begin with the general preparation; 1. Becauſe curves are not ſo eaſily managed as ſtreight lines; the ancients, when they took into conſideration figures terminated, at leaſt on one ſide by a curve, either convex or concave; as A F K E Fig. 9 and 10. Plate IX. often made uſe of ſome ſuch expedient as the following; *viz.* by parallel ſtreight lines as A F, B G, C H, *&c.* at equal or unequal diſtances, as there was occaſion, they divided it into ſo many ſegments at pleaſure; theſe ſegments were ſo many, leſs by one, as the numbers of thoſe parallels; to each of theſe parallels, leſs by one, they fitted parallelograms of ſuch breadths, as were the intervals, equal or unequal, between each of them reſpectively, and the next following; which formed an adſcribed figure conſiſting of theſe parallelograms; and if they began with the greateſt, and therefore neglected the leaſt, ſuch figure was circumſcribed, as Fig. 9. and therefore bigger than the curvilinear propoſed; if with the leaſt, neglecting the greateſt, the figure was inſcribed, as Fig. 10. and therefore leſs than that propoſed; but as the number of ſegments was encreaſed, and thereby their breadths diminiſhed, the difference of the circumſcribed from the inſcribed, and conſequently of either from that propoſed, did continually decreaſe, ſo as at laſt to be leſs than any aſſigned; on which they grounded their method of exhauſtions; in caſes wherein the breadth of the parallelograms, or intervals of the parallels is not to be conſidered, but their length only; or, which is much the ſame, where the intervals are all the ſame, and each reputed = 1; *Archimedes*, inſtead of inſcribed and circumſcribed figures, uſed to ſay, *all except the greateſt*, and *all except the leaſt*.

The particular caſe follows; tho' it be well known, that, in the terreſtrial globe, all the meridians meet at the pole, as E P, E P Fig. 11. whereby the parallels to the equator, as they are nearer the pole, do continually decreaſe; and by this means a degree of longitude in ſuch parallels, is leſs than a degree of longitude in the equator, or a degree of latitude; and that, in ſuch proportion, as is the co-ſine of latitude, which is the ſemi-diameter of ſuch parallel, to the radius of the globe, or of the equator; yet it hath been thought fit, for certain reaſons, to repreſent theſe meridians in the *Sea-chart*, by parallel ſtreight lines, as E *p*, E *p*; whereby each parallel to the equator, as L A, was repreſented in the *Sea-chart*, as *l a*, as equal to the equator E E, and a degree of longitude therein as large as in the equator; by this means, each degree of longitude in ſuch parallels, was increaſed, beyond its juſt proportion, at ſuch rate as the equator, or its radius, is greater than ſuch parallel, or its radius; but in the old *Sea-charts*, the degrees of latitude were repreſented, as they are in themſelves, equal to each other, and to thoſe of the equator; hereby, amongſt many other inconveniencies, the repreſentation of places remote from the equator, was ſo diſtorted in thoſe charts, as that, for inſtance, an iſland in the latitude of 60°, where the radius of the parallel is but half ſo great as that of the equator, would have its length, from eaſt to weſt, in compariſon of its breadth, from north to ſouth, repreſented in a double proportion of what it really was; for rectifying this in ſome meaſure, Mr. *Wright* adviſes, that (the meridians remaining parallel, as before) the degrees of latitude, remote from the equator, ſhould at each parallel, be protracted in like proportion with thoſe of longitude; that is, as the co-ſine of latitude, which is the ſemi-diameter of the parallel, to the radius of the globe, which is that of the equator, ſo ſhould a degree of latitude, which is every where equal to a degree of longitude in the equator, be to ſuch degree of latitude ſo protracted, at ſuch diſtance from the equator, and ſo be repreſented in the chart; that is, every where in ſuch proportion, as is the reſpective ſecant, for ſuch latitude, to the radius; for as the co-ſine is to the radius, ſo is the radius to the ſecant of the ſame arch or angle; as Fig. 12. Σ : R : : R : *ſ*; ſo that, by this means, the poſition of each parallel in the chart, ſhould be at ſuch diſtance from the equator, compared with ſo many equinoctial degrees or minutes (as are thoſe of latitude) as are all the ſecants, taken at equal diſtances in the arch, to ſo many times the radius; which is equivalent, as Mr. *Wright* obſerves, to a projection of the ſphere (ſuppoſing the eye at the center) on the concave ſurface of a cylinder, at right angles to the plane of the equator; and the diviſion of meridians, repreſented by the ſurface of a cylinder erected on the arch of latitude at right angles to the plane of the meridian, or a portion thereof; the altitude of ſuch projection, or portion of ſuch cylindrical ſurface, being, at each point of ſuch circular baſe, equal to the ſecant of latitude anſwering to ſuch point; as Fig. 13. this projection, or portion of the cylindrical ſurface, if expanded into a plane, will be the ſame with a plane figure, whoſe baſe is equal to a quadrantal arch extended, or a portion thereof; on which, as ordinates, are erected perpendiculars equal to the ſecants, anſwering to the reſpective points of the arch ſo extended; the leaſt of which, anſwering to the equinoctial, is equal to the radius, and the reſt continually increaſe till, at the pole, it be infinite, as Fig. 14. ſo that, as E R ſ L, a figure or ſcheme of ſecants erected at right angles on E L, the arch of latitude extended, to E R R L, a rectangle on the ſame baſe, whoſe altitude E R is equal to the radius; ſo is E L, an arch of the equator equal to that of latitude, to the diſtance of ſuch parallel, in the chart, from the equator; for finding this diſtance anſwering to each degree and minute of latitude, Mr. *Wright* adds all the ſecants, as they are found calculated in the trigonometrical canon, from the beginning, to the degree or minute of latitude propoſed; the ſum of all which except the greateſt, anſwering to the figure inſcribed, is too little; the ſum of all except the leaſt, anſwering to the circumſcribed, is too great, which is what he follows; and it would be nearer the truth than either, if, omitting all theſe, we take the intermediates; for *min.* $\frac{1}{2}$, $1\frac{1}{2}$, $2\frac{1}{2}$, $3\frac{1}{2}$, *&c.* or the double of theſe, *min.* 1, 3, 5, 7, *&c.* which yet, becauſe on the convex ſide of the curve, would be ſomewhat too little; but any of theſe ways are exact enough for the intended uſe, as cauſing no ſenſible difference in the chart; if we would be more exact, Mr. *Oughtred* directs, and ſo had Mr. *Wright* done before him, to divide the arch into parts ſtill ſmaller than minutes, and calculate ſecants ſuitable thereto: Since the arithmetic of infinites hath been introduced, and in purſuance thereof, the doctrine of infinite ſeries (for ſuch caſes as would not without them come to a determinate proportion) methods have been found out for ſquaring ſome ſuch figures, and particularly the exterior hyperbola, in a way of continual approach, by the help of an infinite ſeries; in order to a quadrature for this figure of ſecants, by an infinite ſeries fitted thereto; we put R for the *Radius* of a circle; S for the right ſine of an arch or angle; U for the verſed ſine; $\Sigma = R - U = \sqrt{R^2 - S^2}$ for the co-ſine or ſine of the complement; ſ for the ſecant; T for the tangent; then is, Σ : R :: R : ſ; that is Σ) R^2 ($S = \frac{R^2}{\Sigma}$, the ſecant; and Σ : S :: R : T, that is Σ) S R ($T = \frac{SR}{\Sigma}$ the tangent; now, if we ſuppoſe the radius C P, Fig. 15. divided into equal parts, and each of them equal to $\frac{1}{\infty}$ R, and on theſe to be erected the coſines of latitude L A; then are the ſines of latitude in arithmetical progreſſion; and the ſecants anſwering thereto $L\,ſ = \frac{R^2}{\Sigma}$; but theſe ſecants, anſwering to right ſines in arithmetical progreſſion, are not thoſe that ſtand at equal diſtances on the quadrantal arch extended Fig. 14. but ſtanding at unequal diſtances, on the ſame extended arch; *viz.* on thoſe points thereof, whoſe right ſines, whilſt it was a curve, are in arithmetical progreſſion, as Fig. 16. to find therefore the magnitude of R E L ſ Fig. 14. which is the ſame with that of Fig. 16. ſuppoſing E L of the ſame length in both, however the number of ſecants therein may be unequal; we are to conſider the ſecants, tho' at unequal diſtances, Fig. 16. to be the ſame with thoſe at equal diſtances in Fig. 15. anſwering to ſines in arithmetical progreſſion; now theſe intervals, or portions of the baſe, in Fig. 16. are the ſame with the intercepted arches, or portions of the arch, in Fig. 15. for this baſe is only that arch extended; and theſe arches, in parts infinitely ſmall, are to be reputed equivalent to the portions of their reſpective tangents, intercepted between the ſame ordinates; as in Fig. 15. and 17; that is, equivalent to the portions of the tangents of latitude; and theſe portions of tangents are to the equal intervals in the baſe, as the tangent of latitude to its ſine; to find therefore the true magnitude of the parallelograms, or ſegments of the figure, we muſt either protract the equal ſegments of the baſe Fig. 15. in ſuch proportion as is the reſpective tangent to the ſine, to make them equal to thoſe of Fig. 16; or elſe, which is equivalent, retaining the equal intervals of Fig. 15. protract the ſecants in the ſame proportion; for, either way, the intercepted rectangles, or parallelograms, will be equally increaſed, as L M Fig. 17. *viz.* as the ſine of latitude to its tangent, ſo is the ſecant, to a fourth, which is to ſtand on the radius equally divided, inſtead of that ſecant; $S : \frac{SR}{\Sigma} (: : \Sigma : R) : : \frac{R^2}{\Sigma} : \frac{R^3}{\Sigma^2 = R^2 - S^2}$ = L M Fig. 17; which therefore are as the ordinates in the reciprocal ratio of ſecundans, ſuppoſing Σ^2 to be ſquares in order of ſecundans; this (becauſe of $\Sigma^2 = R^2 - S^2$, and the ſines S in arithmetical progreſſion) is reduced by diviſion to this infinite ſeries, $R + \frac{S^2}{R} + \frac{S^4}{R^3}$ &c. that is, putting $R = 1$, $1 + S^2 + S^4$, &c. then according to the arithmetic of infinites, we are to interpret S, ſucceſſively by 1 S, 2 S, 3 S, &c. till we come to S the greateſt, which therefore repreſents the number of the whole; and becauſe the firſt member repreſents a ſeries of equals, the ſecond of ſecundans, the third of quartans, &c. therefore the firſt member is to be multiplied by S, the ſecond by $\frac{1}{3}$ S, the third by $\frac{1}{5}$ S, the fourth by $\frac{1}{7}$ S, &c. which makes the aggregate, $S + \frac{1}{3} S^3 + \frac{1}{7} S^7 + \frac{1}{9} S^9$, &c. = ECLM, Fig. 17; this (becauſe S is always leſs than $R = 1$) may be ſo far continued, till ſome power of S become ſo ſmall, as that it, and all which follow it, may be ſafely neglected; now, (to fit this to the *Sea-Chart*, according to Mr. *Wright*'s deſign) having the propoſed parallel of latitude given, we are to find, by the trigonometrical canon, the ſine of ſuch latitude, and take equal thereto $CL = S$, and by this find the magnitude of ECLM Fig. 17. that is, of RELſ Fig. 16. that is of RELſ Fig. 14; and then, as RRLE, or ſo many times the radius, to RELſ, the aggregate of all the ſecants; ſo muſt a like arch of the equator, equal to the latitude propoſed, be to the diſtance of ſuch parallel, repreſenting the latitude in the chart, from the equator; which is the thing required: The ſame may be obtained in like manner, by taking the verſed ſines in arithmetical progreſſion; for if the right ſines, as here, beginning at the equator, be in arithmetical progreſſion, as 1, 2, 3, &c. then will the verſed ſines, beginning at the pole, as being their complements to the radius, be ſo likewiſe.

The ſame may be in like manner applied to the aggregate of tangents, anſwering to the arch divided into equal parts; for, thoſe anſwering to the radius ſo divided, are $\frac{SR}{\Sigma}$, taking S in arithmetical progreſſion; and then enlarging the baſe, as in Fig. 16, or the tangent as in Fig. 17, in the proportion of the tangent to the ſine; $S : \frac{SR}{\Sigma}$ $(: : \Sigma : R) : : \frac{SR}{\Sigma} : \frac{SR^2}{\Sigma^2} = \frac{SR^2}{R^2 - S^2}$; we have by diviſion this ſeries, $S + \frac{S^3}{R^2} + \frac{S^5}{R^4} + \frac{S^7}{R^6}$ &c. that is, putting $R = 1$, $S + S^3 + S^5 + S^7$, &c

which (multiplying the reſpective numbers by $\frac{1}{2}$S, $\frac{1}{4}$S, $\frac{1}{6}$S, $\frac{1}{8}$S, *&c.*) becomes $\frac{1}{2}S^2 + \frac{1}{4}S^4 + \frac{1}{6}S^6$, *&c.* which is the aggregate of tangents to the arch, whoſe right ſine is S; and this method may be a pattern for the like proceſs in other caſes of the like nature.

The Tendency of the Needle *to a piece of* Iron, *held perpendicular, in ſeveral Climates.* Phil. Tranſ. N° 177. p. 1213.

ALL the way from *England* to 10 deg. N. Lat. the north point of the needle attracted the upper end of the iron, and the ſouth point the lower end, very ſtrongly; N. Lat. 9° 42′, and meridian diſtance from the *Lizard* 9° 32′ weſt, the ſouth point of the needle ſtrongly tended to the lower end of the iron, but the north point did not ſo ſtrongly tend to the upper end as before; and N. Lat. 4° 33′, and meridian diſtance 5° 18′ weſt from the *Lizard*, the north point of the needle began to decline from the upper end of the iron, and the ſouth point to incline more ſtrongly, to the lower end; S. Lat. 00° 52′, and the meridian diſtance 11° 52′ weſt from the *Lizard*, the north point of the needle would neither attract the upper end of the iron, nor the lower end, but the ſouth point did ſtill incline to the lower end, tho' not ſo ſtrongly; S. Lat. 5° 17′, and meridian diſtance 15° 9′ weſt from the *Lizard*; the ſouth point of the needle would turn to the lower end of the iron, about two points, but if the iron was removed any farther, it would fly away from it, and tend to the poles again, but it would not attract the upper end at all, neither would the north point incline to either; but if the iron was laid horizontal, and the extremities of the iron made to tend to the poles of the world, the north point of the needle would turn to the ſouth end of the iron, and contrarily, the ſouth point of the needle, to the north end of the iron, and alter its poſition to the poles 5 or 6 points, and no more; but if the iron was held perpendicular, and its middle were applied to the needle, it would ſtill tend to the poles: S. Lat. 8° 17′, and meridian diſtance from the *Lizard* 17° 35′ weſt, the north point of the needle would not point to the upper end of the iron, but rather fly from it; but the ſouth point would ſtill reſpect the lower end a little, and alter its true poſition about two points; but if the iron were laid aſlope over the compaſs, ſo that its upper end were towards the ſouth pole, and the lower end to the north, then the north point would tend to the lower end, and follow it; but if the upper end pointed to the north, and the lower to the ſouth, the north point would forſake it; but if it was laid horizontal, it would produce the ſame effect, as in the preceeding obſervations: S. Lat. 15° 00′, and 20° 00′ weſt from the *Lizard*, the ſouth point of the needle began to reſpect the upper end of the iron, and the north point, the lower end, and followed it about one point; but if the iron were laid horizontal, the north point would tend to the ſouth end of the iron, and contrary wiſe, &c. S. Lat. 20° 20′ and 19° 20′ weſt from the *Lizard*; the ſouth point of the needle reſpected the upper end of the iron, and the north point the lower end pretty ſtrongly, and followed it three or four points; but if laid horizontal, it would produce the ſame effect as above: S. Lat. 29° 25′ and 13° 10′ weſt from the *Lizard*, the ſouth point of the needle inclined to the upper end of the iron, and the north point to the lower end ſtrongly.

The Solutions of three Chorographic Problems. Phil. Tranſ. N° 177. p. 1231.

THE three following problems may occur at ſea, in finding the diſtance and poſition of rocks, ſands, &c. from the ſhore; or in ſurveying the ſea coaſt, when only two objects, whoſe diſtance from each other is known, can be ſeen at one ſtation; but eſpecially they may be uſeful to one, that would make a map of a country, by a ſeries of triangles, derived from one or more meaſured baſes; which is the moſt exact way of finding the bearing and diſtance of places from each other, and thence their true longitude and latitude; and may conſequently occur to one, that would in that manner meaſure a degree on the earth.

Prob. 1. There are two objects B and C Fig. 18. Plate IX. whoſe diſtance BC is known; and there are two ſtations at A and E, where the objects B, C, being ſeen, and the ſtations one from the other, the angles BAC, BAE, AEB, AEC are known by obſervation; to find the diſtances or lines AB, AC, AE, EC.

Conſtruction; in each of the triangles BAE, CAE, two angles at A, E, being known, the third is alſo known; then take any line $\alpha\varepsilon$ Fig. 19. at pleaſure, on which conſtitute the triangles $\beta\alpha\varepsilon$, $\alpha\varepsilon\gamma$, reſpectively equi-angular to the triangles BAE, AEC, join $\beta\gamma$; then upon BC conſtitute the triangles BCA, BCE, equiangular to the corresponding triangles $\beta\gamma\alpha$, $\beta\gamma\varepsilon$, join AE, and the thing is manifeſtly done.

Calculation; aſſuming $\alpha\epsilon$ of any number of parts; in the triangles $\alpha\beta\epsilon$, $\alpha\gamma\epsilon$, the angles being given, the ſides $\alpha\beta$, $\alpha\gamma$, $\epsilon\beta$, $\epsilon\gamma$, may be found by trigonometry; then in the triangle $\beta\alpha\gamma$, having the angle $\beta\alpha\gamma$, and the legs $\alpha\beta$, $\alpha\gamma$, we may find $\beta\gamma$; then $\beta\gamma : BC :: \beta\alpha : BA :: \beta\epsilon : BE : \gamma\alpha : CA :: \gamma\epsilon : CE$.

Prob. 2. Three objects B, C, D, Fig. 20, are given, or, which is the ſame, the ſides, and conſequently the angles of the triangle BCD are given; alſo there are two points or ſtations A, E; ſuch, that at A may be ſeen the three points B, C, E, but not D; and at the ſtation E may be ſeen A, C, D, but not B; that is the angles BAC, BAE, AEC, AED, (and conſequently, EAC, AEC) are known by obſervation; to find the lines AB, AC, AE, EC, ED.

Conſtruction; take any line $\alpha\epsilon$, Fig. 21, at pleaſure, and at its extremities make the angles $\epsilon\alpha\gamma$, $\epsilon\alpha\beta$, $\alpha\epsilon\gamma$, $\alpha\epsilon\delta$, equal to the correſponding obſerved angles, EAC, EAB, AEC, AED; produce $\beta\alpha$, $\delta\epsilon$, till they meet in φ, join $\varphi\gamma$; then upon CB deſcribe (according to 33. 3 *Euc.*) a ſegment of a circle capable of an angle $= \gamma\varphi\delta$; ſuppoſe F the common ſection of theſe two circles; join FB, FC, FD; then from the point C, produce the lines CA, CE, ſo that the angle FCA may be equal to $\varphi\gamma\alpha$, and $FCE = \varphi\gamma\epsilon$; ſo A and E, the common ſections of CA, CE with FB, FD, will be the points required, from whence the reſt is eaſily deduced.

Calculation; aſſuming $\alpha\epsilon$ of any number of parts, in the triangles $\alpha\gamma\epsilon$, $\alpha\varphi\epsilon$, all the angles being given, with the ſide $\alpha\epsilon$ aſſumed, the ſides $\alpha\gamma$, $\epsilon\gamma$, $\alpha\varphi$, $\epsilon\varphi$, will be known; then in the triangle $\gamma\alpha\varphi$, the angle $\gamma\alpha\varphi$ with the legs $\alpha\gamma$, $\alpha\varphi$ being known, the angles $\alpha\varphi\gamma$, $\alpha\gamma\varphi$ with the ſide $\varphi\gamma$ will be known; then in the triangle BCD all its ſides and angles are known, and the angles BFC, BFD, are equal to $\beta\varphi\gamma$, $\beta\varphi\delta$, which are found; how to find FB, FC, FD, by calculation, and alſo protraction has been ſhewn by Mr. *Collins* in *Philoſophical Tranſactions*, N° 69. p. 2093, as to all its caſes: But it is to be obſerved here, that if the ſum of the obſerved angles BAE, AED, be 180 degrees, then AB and ED cannot meet, becauſe they are parallel, and conſequently the given ſolution cannot take place; on which account another is here ſubjoined.

Another Solution; upon BC, Fig. 22, deſcribe a ſegment BAC of a circle, ſo that the angle of the ſegment may be equal to the obſerved angle $\beta\alpha\gamma$, which is ſhewn by 33. 3. *Euc.* and upon CD deſcribe a ſegment CED of a circle, capable of an angle equal to the obſerved angle CED; from C draw the diameters of theſe circles CG, CH; then upon CG deſcribe a ſegment of a circle GFC, capable of an angle equal to the obſerved angle AEC; likewiſe upon CH deſcribe a ſegment of a circle CFH, capable of an angle equal to the obſerved CAE; ſuppoſe F the common ſection of the two laſt circles HFC, GFC; join FH, cutting the circle HEC in E; join alſo FG, cutting the circle GAC in A; then A and E are the points required.

Demonſtration; the angle BAC is $= \beta\alpha\gamma$, by conſtruction of the ſegment, alſo the angles CEH, CAG, are right, becauſe each of them is in a ſemicircle; therefore a circle, deſcribed upon CF as a diameter, will paſs thro' E and A, and conſequently the angle CAE $=$ the angle CFE $=$ CFH $=$ (by conſtruction) to the obſerved angle $\gamma\alpha\varepsilon$; in like manner the angle CEA $=$ CFA $=$ CFG $=$ obſerved angle $\gamma\varepsilon\alpha$: If the ſtations A, E, fall in a right line with the point C; the lines GA, HE, being parallel, cannot meet; and in this caſe the problem is indeterminate, and capable of infinite ſolutions; for as before, deſcribe upon CG a ſegment of a circle capable of the obſerved angle $\gamma\varepsilon\alpha$, and upon CH deſcribe a ſegment capable of the obſerved angle $\gamma\alpha\varepsilon$; then thro' C, draw a line any way cutting the circles in A and E, theſe points will anſwer the queſtion.

Prob. 3. Four points B, C, D, F, Fig. 23, or the four ſides of a quadrilateral, with the angles comprehended, are given; alſo there are two ſtations A and E ſuch, that at A, only B, C, E, are ſeen, and at E only A, D, F, that is, the angles BAC, BAE, AED, DEF, are given; to find the places of the two points A and E; and conſequently, the lengths of the lines AB, AC, AE, ED, EF.

Conſtruction; upon BC (by 33. 3. *Euc.*) deſcribe a ſegment of a circle, that may contain an angle equal to the obſerved angle BAC; then from C draw the chord CM, or a line cutting the circle in M, ſo that the angle BCM may be equal to the ſupplement of the obſerved angle BAE, *i. e.* its reſidue to 180 degrees; in like manner, on DF deſcribe a ſegment of a circle, capable of an angle equal to the obſerved DEF, and from D draw the chord DN, ſo that the angle FDN may be equal to the ſupplement of the obſerved angle AEF; join MN, cutting the two circles in A and E; which are the two points required.

Demonſtration; join AB, AC, ED, EF, then is the angle MAB $=$ angle BCM (by 21. 3. *Euc.*) $=$ ſupplement of the obſerved angle BAE by conſtruction; therefore the conſtructed angle

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angle B A E is equal to the obſerved one; alſo the angle B A C of the ſegment, is by conſtruction of the ſegment, equal to the obſerved angle B A C; in like manner, the conſtructed angles A E F and D E F are equal to the correſponding obſerved angles A E F and D E F; therefore A and E are the points required.

Calculation; in the triangle B C M, the angle B C M (= ſupplement of B A E) and the angle B M C (= B A C) are given; with the ſide B C, thence M C may be found; in like manner D N in the triangle D N F may be found; but the angle M C D (= B C D — B C M) is known, with its legs M C, C D; therefore its baſe M D, and the angle M D C may be known; conſequently the angle M D N (= C D F — C D M — F D N) is known, with its legs M D, D N; thence M N with the angles D M N, D N M, will be known; then the angle C M A (= D M C + D M N) is known, with the angle M A C (= M A B + B A C) and M C before found; therefore M A and A C will be known: In like manner, in the triangle E D N, the angles E and N, with the ſide D N being known, the ſides E N, E D, will be known; therefore A E (= M N — M A — E N) is known: Alſo in the triangle A B C, the angle A with its ſides B C, C A, being known, the ſide A B will be alſo known, with the angle B C A; ſo in the triangle E F D, the angle E with the ſides E D, D F, being known, E F will be found, with the angle E D F: Laſtly, in the triangle A C D, the angle A C D (= B C D — B C A) with its legs A C and C D being known, the ſide A D will be alſo known, and in like manner E C in the triangle E D C: *Note*, that in this problem, as alſo in the firſt and ſecond, if the two ſtations fall in a right line with either of the given objects, the *Locus* of A or E being a circle, the particular point of A or E cannot be determined from the things given: As to the other caſes of this third problem, wherein A and E may ſhift places, *i. e.* only D, F, E, may be ſeen at A, and only A, B, C at E; or wherein B, D, E, may be ſeen at A, and only C, F, A, at E; or, wherein A may be of one ſide of the quadrilateral, and E on the other; or one of the ſtations within the quadrilateral, and the other without it; the ſurveyor will eaſily direct himſelf by what has been already ſaid.

The ſolution of this third problem is general, and ſerves alſo for the two preceeding; for ſuppoſe C D the ſame point in the laſt figure, and it gives the ſolution of the ſecond problem; but if B, C, be ſuppoſed the ſame points with D, F, by proceeding as in the laſt, you may directly ſolve the firſt problem.

An Inſtrument for finding the Diſtances of Jupiter's Satellites *from his* Axis; *by Mr.* Flamſtead. Phil. Tranſ. N° 178. p. 1262.

THE ſmall circle, Fig. 1. Plate X. in the middle, repreſents the planet *Jupiter*; the four concentric circles, the proper orbits of his four ſatellites, duly proportioned to the breadth of his body; the diſtances between the parallel lines, interſecting them, being each equal to one of his ſemidiameters: The four divided circles, next without theſe, are diſtinguiſhed into ſo many parts, as there are days and hours in each ſatellite's revolution; the innermoſt of them ſerving for the firſt, or innermoſt ſatellite; the next for the ſecond; the next without this, for the third; and the outermoſt for the fourth; above which is a ſmall divided arch of 15 degrees. By this inſtrument to find the diſtances of the ſatellites from *Jupiter*'s axis to a propoſed time. 1. Find the parallax of *Jupiter*'s orbit to the time propoſed, and obſerve whether it be to be added or ſubſtracted. 2. Extend the thread from the centre of the inſtrument over the parallax numbered in the ſmall arch; it cuts off in the four divided circles, ſo many hours, as each ſatellite takes up in paſſing from the axis of the ſhadow to the axis of *Jupiter* viewed from the earth; theſe Mr. *Flamſtead* calls the ſimple paralactic intervals; which, if the parallax was to be added, are alſo additional, if to be ſubſtracted, are likewiſe to be ſubducted. 3. To theſe parallactic intervals add the times of half the duration of the eclipſe of each ſatellite; which, for the firſt, may be aſſumed 1 h. 10 min. for the ſecond, 1 h. 30 min. greater exactneſs being unneceſſary; but for the third and fourth, when eclipſed (their immerſion into the ſhadow, and emerſion from it, being commonly given in the tables) take half the difference of theſe times at the next eclipſe to the time propoſed, for the half duration, and add them to the ſimple parallactic intervals, ſo you have them augmented; but obſerve, that as often as the fourth ſatellite is not eclipſed (which is two years in every ſix) its interval needs no augmentation, the tables ſhewing the very time, when it paſſes the axis of the ſhadow. 4. Find in the tables the times of the eclipſes of each ſatellite immediately preceeding the time propoſed, and when the fourth is not eclipſed, find the time of its paſſing the axis of the ſhadow; to which, if the parallactic intervals augmented were additional, add them to; if ſubductive, ſubſtract them from each, the time of the eclipſe of its proper ſatellite; ſo you have very nearly the apparent times, when each ſatellite laſt paſſed over the axis of *Jupiter* viewed from the earth. 5. Subſtract each of the times thus obtained from the time propoſed, the remainders are the intervals of the motion of each ſatellite from *Jupiter*'s axis. 6. Extend the thread from the centre over each of theſe intervals of motion numbered ſeverally in the divided circles belonging each to its proper ſatellite, where it cuts the proper orbit of that ſatellite, whoſe interval was numbered in its peculiar circle, it ſhews amongſt the parallels, how many ſemidiameters of *Jupiter*, that ſatellite is diſtant from him, and on which ſide of him it is poſited: Obſerve further, that the thread as it lay extended over the parallax of the orbit numbered in the ſmall arch, where it cut the ſeveral proper orbits of each ſatellite, ſhewed amongſt the parallels, how many ſemidiameters of *Jupiter*, the centre of the ſhadow was diſtant from the centre of *Jupiter* viewed from the earth; and that if the parallax of the orbit were additional, the ſhadow lay on the right hand from *Jupiter*; if ſubductive, on the left.

To explain theſe precepts, Mr. *Flamſtead* ſubjoins two brief examples; let it be then propoſed to know how far each ſatellite appears diſtant from *Jupiter* on the 26th of *Dec.* 1685, at 6 h. 52 min. p. m. when the third ſatellite falls into the ſhadow; alſo on *July* 16th, 1686, at 10 h. 00 min. p. m. where is no eclipſe.

Anno 1685. *Dec.* 26 d. 16 h. 52 min. p. m. the parallax of the orbit is 9° 20′ additional; therefore

	1			2			3			4		
	d.	h.	m.	d.	h.	m.	d.	h.	m.	d.	h.	m.
The ſimple parallactic intervals add	0	1	5	0	2	10	0	4	25	0	10	20
The half durations of the eclipſes to be added ——	0	1	10	0	1	30	0	1	18	0	0	0
The parallactic intervals augmented	0	2	15	0	3	40	0	5	43	0	10	20
Laſt immerſions and emerſions, *Dec.*	25	9	37	25	5	47	19	12	58	10	00	30
Times of laſt paſſing *Jupiter*'s axis, *Dec.*	25	11	52	25	9	27	12	18	41	10	10	50
Subſtracted from the time propoſed, *Dec.*	26	16	52	26	16	52	26	16	52	26	16	52

	1	2	3	4
	d. h. m.	d. h. m.	d. h. m.	d. h. m
Leaves the intervals of motion ———	1 5 00	1 7 25	6 22 11	16 6 2
Over which, numbered in their peculiar circles, the thread being ſeverally laid, cuts the proper orbit of each at their viſible diſtances from *Jupiter* ———	ſd. 5 dextrors.	ſd. 6 ½ ſiniſt.	ſd. 3 dext.	ſd. 4 ½ dext.

Again, *Anno* 1686, *July* 16th, 10 h. p. m. the parallax of the orbit is 10° 46′ ſubductive. Hence

	1	2	3	4
	d. h. m.	d. h. m.	d. h. m.	d. h. m.
The ſimple parallactic intervals ſubd.	0 1 12	0 2 35	0 5 10	0 12 00
Half duration of the eclipſes add. ——	0 1 10	0 1 30	0 1 21	
The parallactic intervals augmented	0 2 22	0 4 5	0 6 31	0 12 00
The next laſt emerſions, and paſſing the axis of the ſhadow, *Jul.*	15 5 55	15 22 2	15 9 19	15 17 52
The time of laſt paſſing the viſible axis of *Jupiter* ———	15 3 33	15 17 57	15 2 48	15 5 52
The time propoſed	16 10 00	16 10 00	16 10 00	16 10 00
The intervals of motion ———	1 6 27	0 16 3	1 7 12	1 4 8
Therefore diſtanc. from *Jupiter*'s axis	ſd. 5 ½ dext.	ſd. 8 ½ ſiniſt.	ſd. 13 ½ ſiniſt.	ſd. 10 ½ ſiniſt.

A human Liver *appearing glandulous to the Eye*; *by Mr.* J. Brown. Phil. Tranſ. N° 178. p. 1266.

THE magnitude of this liver was not extraordinary, but it rather ſeemed leſs than uſual; and what was very remarkable, it conſiſted in its concave, convex, and inward parts, glands, which, with the veſſels, made up the whole ſubſtance thereof; theſe glands contained a yellowiſh ichor, like ſo many puſtules, and was probably part of the bilious humour lodged therein, tho' otherwiſe the liver between the glands was of its uſual reddiſh colour; in the gall-bladder, there was found a ſoft friable ſtone.

Explication of the figure; A A A, Fig. 2. Plate X. the glands in the concave part of the leſſer lobe of the liver; B B B the glands in the concave part of the greater lobe of the liver, which were of different magnitudes; tho' in general, they were much leſs in the leſſer, than in the greater; C C C C the inward part of the greater lobe of the liver, as it was divided; D D D D D are ſeveral black ſpecks, that appeared inſerted in thoſe glands, which were probably from the divarications of the veſſels being divided upon opening this lobe; E the gall-bladder, of a greeniſh colour; F the *Vena Porta* tied up with the *Ductus Bilarius*, &c. G a particular ſet of glands; H the *Vena Cava*; I part of the *Ligamentum Suſpenſorium:* The convex part of the liver was, in every reſpect, the ſame with the concave part of both lobes, as to its glands.

On the Strength of Memory; *by Dr.* Wallis. Phil. Tranſ. N° 178. p. 1269.

THE want of ſight proves a conſiderable advantage as to memory and the application thereof; for we, who have the benefit of our eye-ſight, can with more advantage apply our memory, in matters that require cloſe attention, by night in the dark, when all things are quiet and huſhed, than by day, when ſights and noiſe are apt to divert our thoughts; and even by day we may better do it with our eyes ſhut than open: Dr. *Wallis* therefore had the curioſity to try how far the ſtrength of memory would ſuffice him to perform ſome arithmetical operations; as multiplication, diviſion, extraction of roots, *&c.* without the help of pen and ink, or any thing equivalent thereto; and he found it to ſucceed in numbers of 20, 30, or 40 places; particularly he extracted by night in the dark the ſquare root of 3 to the 20 place of decimal fractions; and at the requeſt of a foreigner, he propoſed to himſelf a number of 53 places, and he found its ſquare root to 27 places, and fixing them in his memory, by repeating the ſame operation a night or two after; at the foreigner's next viſit, Dr. *Wallis* dictated to him the numbers from his memory, without previouſly committing them to writing; by which he was ſufficiently ſatisfied, that a tolerable good memory, fixt with good attention, was capable of being charged with more than a man would at firſt imagine.

The Purple-Fiſh; *by Mr.* Will. Cole. Phil. Tranſ. N° 178. p. 1278.

A Certain perſon, living by the ſea-ſide in *Ireland*, made conſiderable profit, by marking fine linnen with a delicate durable crimſon colour, which he did with ſome liquid ſubſtance extracted from a ſhell-fiſh; upon this Mr. *Cole* made ſeveral experiments, on all the ſhell-fiſh taken on that coaſt, till at laſt he obtained that delicate colour; the proceſs of which is as follows: Theſe ſhells, being harder than moſt other kinds, are to be broken with the ſmart ſtroke of a hammer on a plate of iron, or firm piece of timber, with their mouths downwards, ſo as not to cruſh the body of the fiſh within ſide; after picking off the broken pieces, there will appear a white vein, lying tranſverſely in a little furrow or cleft, next to the head of the fiſh, which muſt be dug out with the ſtiff point of a horſe-hair pencil, made ſhort and tapering: The letters, figures, or what elſe ſhall be made on the linnen or ſilk will preſently appear of an agreeable light-green colour, and if placed in the ſun, it will change into the following colours; in winter, about noon; in ſummer, an hour or two after ſun-riſing, and as much before ſetting; for in the heat of the day in ſummer, the colours come on ſo faſt, that the ſucceſſion of each will ſcarce be diſtinguiſhable; *viz.* it will change from a light-green to a deep-green, and then in a few minutes to a full ſea-green; after which, in a few minutes more, it will change into a watchet-blue; and from that, in a little time more, it will become of a purpliſh red; after which, lying an hour or two more, and ſuppoſing the ſun ſtill ſhining, it will turn to a very deep purple-red, beyond which the power of the ſun cannot reach; obſerve that theſe changes are made faſter or ſlower, according to the degrees of the ſun's heat: But the laſt and moſt beautiful colour, after waſhing in ſcalding water and ſoap, will, after expoſing again the matter to the ſun or wind to dry, be of a different colour from all the abovementioned, and become of a fair bright crimſon, or nearly of the prince's colour; which, tho' no ſtyptic, be uſed to bind the colour, will continue the ſame, if well managed; as Mr. *Cole* found in handkerchiefs, that had been waſhed upwards of 40 times, only it would be a little allayed after the firſt waſhing: He alſo made as many large letters, as there were diſtinct colours, on ſo many pieces of cloth, and put them in a book to keep them from the air; in ſeveral months after, the various colours appeared diſtinct as abovementioned; yet by often opening the book, and ſo expoſing them to the air, all the colours, excepting the two laſt, before either was waſhed, would fade; but all the colours being waſhed would become one and the ſame; whilſt the cloth, ſo writ upon, lay in the ſun, it would yield a very ſtrong fetid ſmell, like a mixture of garlick and *Aſſa Fœtida*.

The ſhells are of various colours, but moſt of them white; ſome are red when newly taken off the rocks, ſome yellow, others of both theſe colours, ſome are of a blackiſh brown, many of a ſand-colour, and a few are ſtriped with white and brown parallel lines: It ſeems to be a kind of amphibious animal, alternately living in both elements every tide; and being out of its native place, and in want of ſuch viciſſitudes, it uſes the following ſhift to find the air; when any of them are put into a veſſel of ſea-water, for in freſh water they ſoon expire, after they have lain for ſome time on the bottom of the veſſel, they creep up to the ſurface of the water, and by extending a kind of lip with their *Opercula* or lids, they cling to the ſide of the veſſel, with about half that part above the water, ſometimes creeping down under it, and returning again to their ſtation, between wind and water: Mr. *Cole* found their veins ſometimes fuller and whiter, and the juice more viſcid; at other times more thin and watry: Theſe ſhells are in great plenty on the ſea-coaſt of *Somerſetſhire*, and they are alſo found on the ſhores of *South-Wales* oppoſite thereto: The fiſh boiled and dreſſed is ſaid to be wholeſome food; they are as good at leaſt, and taſte as well as limpots or wrinkles, only the fleſh is ſomething harder: It's colouring-juice may perhaps be the ſpermatic and prolific matter, by which it propagates its ſpecies, which ſeems probable from its conſiſtence, and virulent and fetid ſavour; or elſe it may be a humour in this animal, which, by its vital energy, as the ſprings of life and motion, ſupplies the want of heart, liver, blood, *&c.* as in other blood-leſs animals: There are many ſorts of this purple-fiſh, differing in bigneſs, ſtructure, and colour of the ſhell, according to the nature of the ſea-grounds, depth or ſhallowneſs of water, the nature of rocks, gravel, and mud, as alſo according to the latitude wherein they are found; they alſo differ in the variety of the colours of the tinging juice of their veins, as black, livid, violet, deep ſea-green, light and deep red, amethyſtine, *&c.* but the beſt of all were found in the *Tyrian* ſeas, near that iſland, on which the famous *Tyre* was built; this was celebrated and prized above all the reſt for its rich colour, variouſly denominated in former ages; as *Oſtrum Sacranum*, *Pelagium*, *Venenum Tyrium*, *Purpuriſſum*, *Flores Tyriani*, &c. All authors generally agree, that the juice lies in a certain vein in the fiſh, and ſome mention it to be white and viſcous, as this of ours: This excellent dye ſeems to have arrived at its higheſt perfection in *Pliny*'s days, in the reigns of the *Veſpaſians*, when the artiſts of the imperial city of the world, in preparations of that tinging juice for dying the robes and other veſtments of emperors, ſenators, *&c.* ſtrove to excel each other in new faſhioned purples, to gratify the luxury of the great men of thoſe times; this colour was then ſold at a very high rate, a pound of the fine double-dyed purple of *Tyre*, called *Dibapha*, yielding a thouſand *Roman Denarii*, which is more than 30 *l.* ſterling.

Gravity *and its Properties, the deſcent of heavy Bodies and the Motion of* Projectiles; *by Mr.* Edm. Halley. Phil. Tranſ. N° 179. p. 3.

THE notion of *Des Cartes* ſeems to be entirely incomprehenſible; he would have the particles of his celeſtial matter, by being reflected from the ſurface of the earth, and ſo aſcending from it, to drive down into their places the terreſtrial bodies they find above them; it is very hard to conceive, how a body ſhall be carried downwards by a continual impulſe tending upwards: *Voſſius* and others aſſert the cauſe of the deſcent of heavy bodies, to be the diurnal rotation of the earth upon its axis, without conſidering, that, according to the doctrine of motion, all bodies moving in a circle recede from the centre of their motion; ſo that an effect contrary to gravity would follow, and all looſe bodies would be caſt into the air in a tangent to the parallel of latitude, without the intervention of ſome other principle to keep them faſt, as is that of gravity; beſides, the effect of this principle is found nearly equal all over the ſurface of the globe, and certain experiments ſeems to argue it rather leſs near the *Equator* than towards the *Poles*; which could never be the caſe, if the diurnal rotation of the earth were the cauſe of gravity; for where the motion is ſwifteſt, there the effect is the moſt conſiderable: Others aſſign the preſſure of the atmoſphere as the cauſe of this tendency towards the centre of the earth; but unhappily they have miſtaken the effect for the cauſe, it being plain from undoubted principles, that the atmoſphere hath no other preſſure,

ſure, but what it derives from its gravity; and that the weight of the upper parts of the air, preſſing on the lower, do ſo far bend the ſprings of that elaſtic body, as to give it a force equal to the weight that compreſſed it, having of itſelf no force at all; and ſuppoſing it had, it will be very hard to explain the *Modus*, how that preſſure ſhould occaſion the deſcent of a body circumſcribed by it, and preſſed equally above and below, without ſome other force to draw or thruſt it downwards; but to demonſtrate the contrary of this opinion, an experiment was ſhewn before the Royal Society, whereby it appeared, that the atmoſphere was ſo far from being the cauſe of gravity, that the effects thereof were much more vigorous when the preſſure of the atmoſphere was removed; for upon exhauſting a long glaſs receiver, a light down-feather included therein, which, in the air would hardly ſink, did deſcend *in Vacuo* with nearly the ſame velocity as if it had been a ſtone: Some people think to illuſtrate this deſcent of heavy bodies, by comparing it with the virtue of the loadſtone; but ſetting aſide the difference in their manner of attraction, the loadſtone attracting only in and about its *Poles*, and the earth almoſt equally in all parts of its ſurface; this compariſon avails no more than to explain one unknown thing by another equally ſo: Others aſſign as the cauſe a certain ſympathetical attraction between the earth and its parts, whereby, they have, as it were, a deſire to be united; but this is ſo far from explaining the *Modus*, that it is little more than telling us in other terms, that heavy bodies deſcend, becauſe they deſcend: But tho' the efficient cauſe of gravity be ſo obſcure, yet its final cauſe is clear enough; for it is by this ſingle principle that the earth and all the celeſtial bodies are kept from diſſolution; the leaſt particle not being ſuffered to recede far from their ſurfaces, without being immediately brought down again by virtue of this natural tendency; which, for their preſervation, the infinite wiſdom of their creator hath ordained to be towards each of their centres; nor can the globes of the ſun and planets otherwiſe be deſtroyed, than by depriving them of this power of keeping their parts united.

The affections or properties of gravity, and its manner of acting on falling bodies, have been in a great meaſure diſcovered, and moſt of them made out by mathematical demonſtration, by the accurate diligence of *Galileo*, *Torricelli*, *Huygens*, Mr. *Newton* and others. 1. The firſt property is, that by this principle of gravitation, all bodies deſcend towards a point, which either is, or elſe very near the centre of magnitude of the earth and ſea, about which the ſea forms itſelf exactly into a ſpherical ſurface, and the prominences of the land, conſidering the bulk of the whole, differ but inſenſibly therefrom. 2. This point or centre of gravitation is fixed within the earth, or at leaſt hath been ſo, ever ſince we have had any authentic hiſtory; for a conſequence of its change, tho' never ſo little, would be the overflowing of the low-lands on that ſide of the globe towards which it approached, and the leaving new iſlands bare on the oppoſite ſide, from which it receded; but for theſe two thouſand years it appears, that the low iſlands of the *Mediterranean Sea*, near which the moſt ancient writers lived, have continued much at the ſame height above the water, as they now are found; and no inundations or receſſes of the ſea, arguing any ſuch change, are recorded in hiſtory, excepting the univerſal deluge, which can no better way be accounted for, than by ſuppoſing this centre of gravitation removed for a time towards the middle of the then inhabited parts of the world; and a change of its place, but the two thouſandth part of the radius of this globe, would be ſufficient to bury the tops of the higheſt hills under water. 3. That in all parts of the ſurface of the earth, or rather in all points equi-diſtant from its centre, the force of gravity is nearly equal; ſo that the length of a pendulum, vibrating ſeconds of time, is found in all parts of the world to be nearly the ſame: It is true, that, at St. *Helena*, in the latitude of 16° ſouth, Mr. *Halley* found that the pendulum of his clock, which vibrated ſeconds, required to be made ſenſibly ſhorter than it had been in *England*, before it would keep time, and afterwards the *French* obſervers found the ſame thing near the equinoctial; and Mr. *Halley* could aſcribe this to no other cauſe, than to the great height of his place of obſervation above the ſurface of the ſea, whereby the gravity being diminiſhed, the length of the pendulum, vibrating ſeconds, muſt be proportionably ſhortened. 4. Gravity does equally affect all bodies, without regard either to their matter, bulk, or figure; ſo that the reſiſtance of the medium being removed, the compacteſt and looſeſt, the greateſt and ſmalleſt bodies, would deſcend the ſame ſpaces in equal times; as appears from the experiment abovementioned: In theſe two laſt particulars, is ſhewn, the great difference between gravity and magnetiſm; the one affecting iron only, and that towards its poles, the other all bodies alike in every part: From hence it will follow as a corollary, that there is no ſuch thing as poſitive levity, thoſe things that appear light, being only comparatively ſo; and whereas things riſe and ſwim in fluids, it is becauſe, bulk for bulk, they are not ſo heavy as thoſe fluids; nor is there any reaſon, why cork, for inſtance, ſhould be ſaid to be light, becauſe it ſwims on water, any more than iron, becauſe it ſwims on mercury. 5. That this power encreaſes as you deſcend to, and decreaſes, as you aſcend from the centre, and that in the proportion of the ſquares of the diſtances therefrom reciprocally, ſo as at a double diſtance to have but a quarter of the force; this property is the principle, on which Mr. *Newton* hath made out all the phænomena of the celeſtial motions, in ſuch an eaſy and natural manner, that its truth is paſt diſpute; beſides, it is highly rational, that the attractive or gravitating power ſhould exert itſelf more vigorouſly in a ſmall ſphere, and leſs ſo in a greater, in proportion as it is contracted or expanded; and if ſo, ſeeing the ſurfaces of ſpheres are as the ſquares of their *Radii*, this power at ſeveral diſtances will be as the ſquares of thoſe diſtances reciprocally; and then its whole action on each ſpherical ſurface, be it great or ſmall, will be always equal; and this is evidently the rule of gravitation towards the centres of the *Sun*, *Jupiter*, *Saturn*, and the *Earth*; and is thence reaſonably inferred, to be the general principle obſerved by nature in the other celeſtial bodies.

Theſe are the principal affections of gravity, from which the rules of the fall of bodies, and the motion of projectiles, are mathematically deducible: Mr. *Newton* hath ſhewn how to define the ſpaces of the deſcent of a body, let fall from any given height, down to the centre, on the ſuppoſition of the increaſe of gravitation, as in the fifth property; but conſidering the ſmall height, to which any projectile can be made to aſcend, and over how ſmall an arch of the globe, it can be caſt by any of our engines, we may well enough ſuppoſe the gravity to be equal throughout; and the deſcents of projectiles to be in parallel lines, which, in reality, are towards the centre, the difference being ſo ſmall as by no means to be diſcovered in practice; the oppoſition of the air, it is true, is conſiderable againſt all light bodies, but in great and ponderous ſhot, this impediment is found by experience to be inconſiderable and may ſafely be neglected: Propoſitions concerning the deſcent of heavy bodies, and the motion of projects.

Propoſition I. The velocities of falling bodies are proportional to the times, from the beginning of their falls: For the action of gravity being continual, in every ſpace of time, the falling body receives a new impulſe, equal to what it had before, in the ſame ſpace of time, received from the ſame power; for inſtance, in the firſt ſecond of time, the falling body hath acquired a velocity, which in that time would carry it to a certain diſtance, ſuppoſe 32 foot, and if there were no new force, it would deſcend at that rate with an equable motion; but in the next ſecond of time, the ſame power of gravity continually acting thereon, ſuperadds a new velocity equal to the former; ſo that at the end of two ſeconds, the velocity is double to what it was at the end of the firſt; and in the ſame manner, it may be ſhewn to be triple, at the end of the third ſecond, and ſo on; wherefore the velocities of falling bodies are proportional to the times of their falls. Q. E. D.

Propoſition II. The ſpaces, deſcribed by the fall of a body, are as the ſquares of the times from the beginning of the fall: Let A B Fig. 3. Plate X. repreſent the time of the fall of a body; B C, a perpendicular to A B, the velocity acquired at the end of the fall; and draw the line A C; then divide the line A B, repreſenting the time, into as many equal parts as you pleaſe, as *b*, *b*, *b*, *b*, *&c.* and thro' theſe points draw the lines *b c*, *b c*, *bc*, *&c.* parallel to B C; it is manifeſt that the ſeveral lines *b c*, repreſent the ſeveral velocities of the falling body, in ſuch parts of time, as A *b* is of A B, by the former propoſition: It is likewiſe evident, that the area A B C is the ſum of all the lines *b c*, taken infinitely many according to the method of indiviſibles; ſo that the area A B C, repreſents the ſum of all the velocities between none and B C, ſuppoſed infinitely many; which ſum is the ſpace deſcended in the time repreſented by A B; and by the ſame reaſon, the areas A *b c* will repreſent the ſpaces deſcended in the time A *b*; ſo then the ſpaces, deſcended in the times A B, A *b*, are as the areas of the triangles A B C, A *b c*, which, by the 20th of the 6th of *Euclid*, are as the ſquares of their homologous ſides A B, A *b*, that is, of the times; wherefore the deſcents of falling bodies are as the ſquares of the times of their fall. Q. E. D.

Propoſition III. The velocity, which a falling body acquires in any ſpace of time, is double to that, wherewith it would have moved the ſpace deſcended by an equable motion, in the ſame time: Draw the line E C parallel to A B, and A E parallel to B C, and compleat the parallelogram A B C E; it is evident, that its area may repreſent the ſpace, a body moved equably with the velocity B C, would deſcribe in the time

A B; and the triangle A B C, repreſents the ſpace, deſcribed by the fall of a body, in the ſame time A B, by the ſecond propoſition; now the triangle A B C, is half the parallelogram A B C E; and conſequently the ſpace, deſcribed by the fall, is half what would have been deſcribed by an equable motion with the velocity B C, in the ſame time; wherefore the velocity B C, at the end of the fall, is double to that velocity, which, in the time A B, would have deſcribed the ſpace fallen, repreſented by the triangle A B C, with an equable motion. Q. E. D.

Propoſition IV. All bodies, on or near the ſurface of the earth, do in their fall deſcend in ſuch a manner, as at the end of the firſt ſecond of time to have deſcribed 16 foot one inch, *London* meaſure, and acquired the velocity of 32 foot, two inches in a ſecond: This is made out from the 25th *Prop. Par. 2. Horol. Oſcill. Huygen.* wherein, he demonſtrates the time of the leaſt vibrations of a pendulum, to be to the time of the fall of a body, from the height of half the length of the pendulum, as the circumference of a circle to its diameter; whence, as a corollary it follows, that as the ſquare of the diameter is to the ſquare of the circumference, ſo is half the length of the pendulum, vibrating ſeconds, to the ſpace deſcribed by the fall of a body in a ſecond of time; and the length of the pendulum, vibrating ſeconds, being found 39, 125, or ⅛ inches, the deſcent in a ſecond will be found, by the above analogy, 16 foot and one inch; and by the third propoſition, the velocity will be double thereto; and thus nearly it hath been found by ſeveral experiments, which, by reaſon of the ſwiftneſs of the fall, cannot ſo exactly determine its quantity: From theſe four propoſitions, all queſtions concerning the perpendicular fall of bodies are eaſily ſolved, and either time, height, or velocity being aſſigned, one may readily find the other two: The doctrine of projectiles is alſo deducible from them, aſſuming the two following axioms; *viz.* 1. That a body, put in motion, will move on continually in a right line with an equable velocity, unleſs ſome other force or impediment intervene, whereby it is either accelerated, retarded or deflected. 2. That a body, being agitated by two motions at a time, does by their compounded forces paſs thro' the ſame points, as it would have done, were the two motions divided and acted ſucceſſively; as for inſtance, ſuppoſe a body moved in the line G F Fig. 4, from G to R, and ſtopping there, ſuppoſe it moved by another impulſe in a ſpace of time equal to the former

former from R towards K and U; I ſay, the body will paſs thro' the point U, tho' theſe two ſeveral forces acted both at the ſame time.

Propoſition V. The motion of all projectiles is in the curve of a parabola: Let the line G R F be that in which the project is directed, and wherein, by the firſt axiom, it would have moved equal ſpaces in equal times, were it not deflected downwards by the force of gravity; let G B be the horizontal line, and G C a perpendicular thereto; then the line G R F, being divided into equal parts, anſwering to equal ſpaces of time, let the deſcents of the projectile be laid down in lines parallel to G C, proportioned as the ſquares of the lines G S, G R, G L, G G, or as the ſquares of the times, from S to T, from R to U, from L to X, and from F to B; and draw the lines T H, U D, X Y, B C parallel to G F; I ſay, the points T, U, X, B, are points in the curve deſcribed by the project, and that that curve is a parabola; by the ſecond axiom, they are points in the curve; and the parts of the deſcent G H, G D, G Y, G C = S T, R U, L X, F B, being as the ſquares of the times, by the ſecond propoſition; that is, as the ſquares of the ordinates H T, D U, Y X, C B equal to G S, G R, G L, G F, the ſpaces meaſured in thoſe times; and there being no other curve but the parabola, the parts of whoſe diameter are as the ſquares of the ordinates; it follows, that the curve deſcribed by a project can be no other than a parabola; and ſaying, as R U, the deſcent in time, to G R or U D, the direct motion in the ſame time, ſo is U D to a third proportional; that third will be the line, called by all writers of *Conics*, the parameter of the parabola to the diameter G C; which is always the ſame in projects caſt with the ſame velocity; and the velocity, being defined by the number of feet moved in a ſpace of time, the parameter will be found by dividing the ſquare of the velocity by 16 foot 1 inch, the fall of a body in the ſame time.

Lemma. The ſine of the double of any arch is equal to twice the ſine of that arch into its coſine, divided by *Radius*; and the verſed ſine of the double of any arch is equal to the ſquare of its ſine, divided by *Radius:* Let the arch B C Fig. 5. be double the arch B F, and let A be the centre; draw the *Radii* A B, A F, A C, and the chord B D C, and let fall B E perpendicular to A C; and the angle E B C will be equal to the angle B A D; and the triangle B C E will be ſimilar to the triangle A B D; wherefore, it will be, as A B to A D; ſo B C or twice BD to BE; that is, as radius to co-ſine; ſo twice the ſine to the ſine of the double angle; and as A B to B D; ſo twice B D or B C to EC; that is, as radius to ſine, ſo twice that ſine to the verſed ſine of the double arch; which two analogies reſolved into equations, are the propoſitions, contained in the lemma, to be proved.

Prop. VI. The horizontal diſtance of projections made with the ſame velocity, at ſeveral elevations of the line of direction, are as the ſines of the double angles of elevation: Let G B, Fig. 4, the horizontal diſtance be $= z$; the ſine of the angle of elevation F G B be $= ſ$, its co-ſine $= c$, the radius $= r$, and the parameter $= p$; it will be, as c to $ſ$, ſo $\frac{ſz}{c} =$ F B $=$ G C; and by reaſon of the parabola $\frac{pſz}{c} =$ to the ſquare of C B or G F; now as c is to r, ſo is z to $\frac{zr}{c}$. $=$ G F, and its ſquare $\frac{zzrr}{cc}$ will therefore be $=$ to $\frac{pſz}{c}$ which equation reduced will be $\frac{pſc}{rr} = z$; but by the former lemma, $\frac{2ſc}{r}$ is $=$ to the ſine of the double angle, whereof $ſ$ is the ſine; wherefore it will be, as radius to the ſine of double the angle F G B, ſo is half the parameter, to the horizontal range, or diſtance, ſought; and at the ſeveral elevations, the ranges are as the ſines of the double angles of elevation. Q. E. D.

Coroll. Hence it follows, that half the parameter is the greateſt random, and that it happens at the elevation of 45°, the ſine of whoſe double is radius; likewiſe, that the ranges equally diſtant above and below 45° are equal, as are the ſines of all double arches to the ſines of their double complements.

Prop. VII. The altitudes of projections, made with the ſame velocity, at ſeveral elevations, are as the verſed ſines of the double angles of elevation; as c is to $ſ$, ſo is $\frac{pſc}{rr} =$ GB, to $\frac{pſſ}{rr} =$ B F, and U K $=$ R U $= \frac{1}{4}$ B F the altitude of the projection $= \frac{pſſ}{4rr}$; now by the preceeding lemma $\frac{2ſſ}{r} =$ to the verſed ſine of the double angle; and therefore it will be as radius to the verſed ſine of double the angle F G B, ſo $\frac{1}{4}$ of the parameter to the height of the projection U K; and ſo theſe heights are at ſeveral elevations as the ſaid verſed ſines. Q. E. D.

Coroll. From hence it is plain, that the greateſt altitude of the perpendicular projection is a 4th of the parameter, or half the greateſt horizontal range, the verſed ſine of 180° being $= 2r$.

Prop. VIII. The lines G F, or times of the flight of a projectile, caſt with the ſame degree of velocity at different elevations, are as the ſines of the elevations: As c is to r, ſo is $\frac{pſc}{rr} =$ G B (by *Prop.* 6.) to $\frac{pſ}{r} =$ G F, that is, as radius to the ſine of elevation, ſo the parameter to the line G F; ſo the lines G F are as the ſines of elevation, and the times are proportional to thoſe lines; wherefore the times are as the ſines of elevation.

Prop. IX. *Prob.* 1. A projection being made at pleaſure, having the diſtance and altitude, or deſcent of an object, thro' which the project paſſes, together with the angle of elevation of the line of direction, to find the parameter and velocity; that is, (having the angle F G B) G M and M X: For as the radius to the ſecant of F G B, ſo G M the diſtance given to G L; and as radius to tangent of F G B, ſo G M to L M; then L M — M X in heights, or + M X in deſcents; or elſe M X — M L, if the direction be below the horizontal line, is the fall in the time, that the direct impulſe, given in G, would have carried the project from G to L = L X = G Y; then by reaſon of the parabola, as L X or G Y is to G L or Y X, ſo is G L to the parameter ſought: To find the velocity of the impulſe, by *Prop.* 2. and 4, find the time in ſeconds, in which a body would fall thro' the ſpace L X, and by that, dividing the line G L, the quotient will be the velocity, or ſpace, run over in a ſecond, which is always a mean proportional between the parameter, and 16 foot 1 inch.

Prop. X. *Prob.* 2. Having the parameter, the horizontal diſtance, and height or deſcent of an object, to find the elevations of the lines of direction neceſſary to hit the given object; that is, having G M, M X, and the greateſt random equal to half the parameter, to find the angles F G B: Let the tangent of the angle ſought be $= t$, the horizontal diſtance G M $= b$, the altitude of the object M X $= h$, the parameter $= p$, and radius $= r$; and it will be as r to t, ſo b to $\frac{tb}{r}$ = ML; and

$\frac{tb}{r} \mp h$ in $\left\{\begin{matrix}\text{aſcents}\\ \text{deſcents}\end{matrix}\right\} = LX$, and $\frac{ptb}{r} \mp ph = GL^2 = XY^2$, becauſe of the parabola; but $bb + \frac{ttbb}{rr} = GL^2$ (47. 1. *Euc.*) wherefore $\frac{ptb}{r} \mp ph = bb + \frac{ttbb}{rr}$; which equation tranſpoſed is $\frac{ttbb}{rr} = \frac{ptb}{r} \mp ph - bb$; and divided by bb, is $\frac{tt}{rr} = \frac{pt}{br} \mp \frac{ph}{bb} - 1$: This equation ſhews, that the queſtion hath two anſwers, and the roots thereof are $\frac{t}{r} = \frac{p}{2b} + \sqrt{\frac{pp \mp 4ph}{4bb} - 1}$; from which the following rule is derived; divide half the parameter by the horizontal diſtance, and keep the quotient, *viz.* $\frac{p}{2b}$; then ſay, as ſquare of the diſtance given to half the parameter, ſo half the parameter $\left\{\begin{matrix}-\\+\end{matrix}\right\}$ double $\left\{\begin{matrix}\text{height}\\ \text{deſcent}\end{matrix}\right\}$ to the ſquare of a ſecant $= \frac{pp \mp 4ph}{4bb}$, the tangent anſwering to that ſecant will be $\sqrt{\frac{pp \mp 4ph}{4bb} - 1}$, or rr; ſo then the ſum and difference of the quotient above found, and this tangent will be the root of the equation, and the tangents of the elevations ſought.

Note here, that in deſcents, if the tangent exceed the quotient, as it does when ph is more than bb, the direction of the lower elevation will be below the horizon; and if $ph = bb$, it muſt be directed horizontally, and the tangent of the upper elevation will be $\frac{pr}{b}$: *Note likewiſe*, that if $4bb + 4ph$ in aſcents, or $4bb - 4ph$ in deſcents be = to pp, there is but one elevation that can hit the object, and its tangent is $\frac{pr}{2b}$; and if $4bb + 4ph$ in aſcents, or $4bb - 4ph$ in deſcents, do exceed pp, the object is without the reach of a project caſt with that velocity, and ſo the thing is impoſſible: From this equation, $4bb \mp 4ph = pp$ are determined the utmoſt limits of the reach of any project, and the figure aſſigned, ed, wherein are all the heights upon each horizontal diſtance, beyond which it cannot paſs; for by reduction of that equation, h will be found $= \frac{1}{4}p - \frac{bb}{p}$ in heights, and $\frac{bb}{p} - \frac{1}{4}p$ in deſcents; from whence it follows, that all the points h are in the curve of the parabola, whoſe *Focus* is the point from whence the project is caſt, and whoſe *Latus Rectum*, or parameter to the axis is $= p$; likewiſe from the ſame equation may the leaſt parameter, or velocity, be found, capable to reach the object propoſed; for $bb = \frac{1}{4}pp \mp ph$ being reduced, $\frac{1}{2}p$ will be $= \sqrt{bb + hh} \left\{ \begin{matrix} + h \text{ in aſcents} \\ - h \text{ in deſcents} \end{matrix} \right\}$ which is the horizontal range at 45° that would reach the object, and the elevation requiſite will be eaſily had; for dividing the ſemi-parameter ſo found by the horizontal diſtance given, b, the quotient into the radius will be the tangent of the elevation ſought: This rule may be of good uſe to all bombardeers and gunners, not only that they may uſe no more powder than is neceſſary to caſt their bombs into the place aſſigned, but that they may ſhoot with much more certainty, for that a ſmall error committed in the elevation of the piece, will produce no ſenſible difference in the fall of the ſhot; for which reaſons, the *French* engineers uſed mortar-pieces inclined conſtantly at the elevation of 45°, proportioning their charge of powder according to the diſtance of the object they intended to ſtrike on the horizon: If a geometrical conſtruction of this problem be required, the following is a very eaſy one, and deduced from the foregoing analytical ſolution, *viz.* $\frac{t}{r} = \frac{p}{2b} \mp \frac{\sqrt{\frac{1}{4}pp \mp ph - bb}}{bb}$; and it is this; having made the right angle GDF, Fig. 6, make DF $= p$, or greateſt range; DG $= b$, the horizontal diſtance; and DB $= h$, the perpendicular height of the object; to be laid upwards from D; if the object be above the horizon, or downwards, if below it; parallel to GD draw FA, and make it = to GB, the hypothenuſal diſtance of the object; and from the centre A with the radius FB $= \frac{1}{2}p \mp h$ ſweep an arch, which ſhall, if the thing be poſſible, interſect the indeterminate perpendicular DF in two points K and L, to which draw the lines GL, GK; I ſay, the angles DGK, DGL are the elevations requiſite to ſtrike the object B: For the ſquare of FK or FL is = to $FB^2 - GB^2$; or $\overline{\tfrac{1}{2}p \mp h}|^2$

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$^2 - bb - hh$, or $\frac{1}{4}pp \mp ph - bb$; and therefore $\sqrt{\frac{1}{4}pp \mp ph - bb}$ is $=$ FK $=$ FL, and by conſequence DK, DL $= \frac{1}{2}p + \sqrt{\frac{1}{4}pp \mp ph - bb}$; and as DG to DK, and DL; ſo is radius to tangents ſought, which coincides with the algebraical expreſſion thereof.

Prop. XI. To determine the force or velocity of a project, in every point of the curve it deſcribes: To do this, we need no other *Præcognita*, than only the third propoſition, *viz.* that the velocity of falling bodies, is double to that, which in the ſame time, would have deſcribed the ſpace fallen by an equable motion; for the velocity of a project is compounded of the conſtant equal velocity of the impreſſed motion, and the velocity of the fall, under a given angle, *viz.* the complement of the elevation; for inſtance, in the time wherein the project would move from G to L, Fig. 4, it deſcends from L to X, and by the third propoſition hath acquired a velocity, which, in that time, would have carried it by an equable motion from L to Z, or twice the deſcent LX; and drawing the line GZ, I ſay, the velocity in the point X, compounded of the velocities GL and LZ, under the angle GLZ, is to the velocity impreſſed in the point G, as GZ is to GL; this follows from the ſecond axiom, and by 20 and 21 *Prop. Lib.* 1. *Conic Mydorgii*, XO parallel and equal to GZ will touch the parabola in the point X; ſo that the velocities, in the ſeveral points, are as the lengths of the tangents to the parabola in thoſe points, intercepted between any two diameters; and theſe again are as the ſecants of the angles, which thoſe tangents produced make with the horizontal line GB: From what is here laid down, the comparitive force of a ſhot, in any two points of the curve, may be either geometrically or arithmetically diſcovered.

Coroll. From hence, it follows, that the force of a ſhot is always leaſt at U, or the vertex of the parabola, and that at equal diſtances therefrom, as at T and X, G and B, its force is always equal, and that the leaſt force in U is to that in G and B, as radius to the ſecant of the angle of elevation FGB.

The tenth propoſition contains a problem, untouched by *Torricelli*, and which is of the greateſt uſe in gunnery; it was firſt ſolved by Mr. *Anderſon*, in his book of the *Genuine Uſe and Effects of the Gun*, printed in 1674; but his ſolution required ſo much calculation, that it ſet Mr. *Halley* on finding out one more eaſy; and accordingly he diſcovered in 1678 the above-mentioned rule, and its geometrical conſtruction.

Now theſe rules would be rigidly true, were it not for the reſiſtance of the medium, whereby not only the direct impreſſed motion is continually retarded, but there is likewiſe an increaſe of the velocity of the fall, ſo that the ſpaces, deſcribed thereby, are not exactly as the ſquares of the times: But what this reſiſtance of the air is, againſt ſeveral velocities, bulks, and weights, is not ſo eaſy to determine; it is certain, that the weight of air to that of water is nearly as 1 to 800; whence the weight thereof, to that of any project is given: It is very likely, that to the ſame velocity and magnitude, but of different matter, the oppoſition ſhould be reciprocally as the weights of the ſhot; as alſo, that to ſhot of the ſame velocity and matter, but of different ſizes, it ſhould be as the diameters reciprocally; whence generally, the oppoſition to ſhot with the ſame velocity, but of different diameters and materials, ſhould be as their ſpecific gravities into their diameters reciprocally; but whether the oppoſition, to different velocities of the ſame ſhot, be as the ſquares of thoſe velocities, or as the velocities themſelves, or otherwiſe, is yet a harder queſtion; however it be, it is certain, that in large ſhot of metal, whoſe weight ſurpaſſes that of the air many thouſand times, and whoſe force is very great in proportion to the ſurface, wherewith they preſs thereon, this reſiſtance is ſcarcely diſcernible; for by ſeveral experiments, made with the greateſt care and circumſpection with a mortar-piece extraordinary well fixed to the earth on purpoſe, which carried a ſolid braſs ſhot of 4 $\frac{1}{2}$ inches diameter, and of about 14 pound weight, the ranges, above and below 45° were found nearly equal; if there was any difference, the under ranges went rather the fartheſt, but theſe differences were uſually leſs than the errors committed in ordinary practice, by the unequal goodneſs and dryneſs of the ſame ſort of powder, by the unfitneſs of the ſhot to the bore, and by the looſeneſs of the carriage: In a ſmaller braſs-ſhot of about an inch and a half diameter, caſt by a croſs-bow, which ranged it at moſt about 400 foot, the force being much more equal than in the mortar-piece, this difference was found more nicely; and very plainly the under ranges conſtantly exceeded the upper; from which trials it is concluded, that altho', in ſmall and light ſhot, the oppoſition of the air ought, and muſt be accounted for; yet in ſhooting of great and weighty bombs, there need be very little or no allowance made; and ſo theſe rules may be put in practice to all intents and purpoſes, as if this impediment were abſolutely removed.

Shooting *by the Rarefaction of the Air*; *by Dr.* Papin. Phil. Tranſ. N° 179. p. 21.

WHereas ordinary wind-guns produced their effects by the compreſſion of the air; *Otho Guerick* found out a new ſort, that ſhot by rarefaction; but Dr. *Papin* contrived another that ſeemed to exceed it: A A, Fig. 1. Plate XI. is a pipe, very equal from one end to the other; B B a ſmall pipe ſoldered in a hole, near the end of the pipe A A, and applied to the plate of the pneumatic engine; C C a kind of ſtool to bear up the hinder part of the pipe A A; D a piece of lead fitted to the bore of the pipe A A; the pipe A A is to be ſhut at both ends by valves outwardly applied, and ſo the ſaid pipe A A, tho' never ſo big, may be exhauſted of air by means of the pneumatic engine; which done, the valve towards D muſt be ſuddenly opened, ſo that the whole preſſure of the atmoſphere, acting upon the lead D, may drive it along the pipe A A, with ſuch a ſwiftneſs, that it will be able to carry it to a great diſtance; and becauſe ſuch a valve, ſhutting a great hole, would prove very difficult to be opened, when the pipe A A is of a great bore; the aperture, towards D, may be left much ſmaller than the pipe; the ſwiftneſs of the air, being ſo great, that even thro' a pretty ſmall aperture, it preſſed the lead D, as freely almoſt, as if the whole bore was quite open: Having prepared a barrel, carrying a lead of two ounces, the experiment was ſhewn before the Royal Society, and the effect was found very conſiderable, the force being little leſs than that of the wind-gun by compreſſion; the ſame experiment being afterwards repeated with a longer barrel, it was found that the length, in this way of ſhooting was very little, if any advantage.

A Deſcription of ſome ſimple Colours; *by Mr.* Rich. Waller. Phil. Tranſ. N° 179. p. 22.

SImple blues; 1. *Spaniſh* white is made of chalk and alum burnt together. 2. Mr. *Waller* takes the *Lapis Armenius* to be the blue bice of the ſhops, for it is light and friable, formerly brought from *Armenia*, now from the ſilver-mines of *Germany*, called *Melochites*, and *Bergblau* in *High-Dutch*.

3. Ultramarine is made of the blueſt *Lapis Lazuli*, which is freeſt of gold veins, by calcination. 4. Smalt is made of zaffer and pot-aſhes, calcined together in a glaſs-furnace. 5. Litmaſe, or litmoſe, Mr. *Waller* ſuppoſes to be the juice of a plant. 6. Indigo, ſaid by *Pliny* to be brought from *India*, a kind of mud adhering to the froth about reeds, and when tried with a coal, the true ſort burns with a purple flame, and ſmells of the ſea: *Linſchoten* ſays, it is called *Anil*, that it grows in *Cambaia*, and that it is a plant like roſemary, which is gathered and dried, then moiſtened with fair water, and beaten to a mud. 7. *Indian* ink; its uſe was known to *Pliny*, tho' not its compoſition, which is yet undiſcovered, unleſs it be burnt rice, as hath been thought.

Simple yellows and reds; 1. Ceruſe is the ruſt of lead, made by a vaporous calcination: *Pliny* writes thus of it, *Cap.* 34. *Lib.* 18, *Pſimmithium*, or ceruſe is made in the plumber's ſhops of ſmall plates of lead laid upon a veſſel of ſtrong vinegar; what falls into the vinegar is taken out, and dried in the ſun; and *Cap. 6. Lib.* 35, he ſays, it was made at *Rome* of burnt marble-flint quenched in vinegar. 2. Maſticot is a kind of improper calx, or tin. 3. *Guttæ Gambæ*, or *Cambodia*, is the inſpiſſated juice of a plant, not well known; it comes from both the *Indies*: Some think it is the juice of *Euphorbium*; others, of ſcammony, or tithymal; others, of *Ricinus*; others again refer it to the greater *Cataputia*, *Eſula*, or the flowers of the *Indian Ricinus*, and will have it coloured with *Turmeric*, as *Schroder* would have. 4. Oker, a kind of natural earth; there are two ſorts thereof; the one native, formerly brought from *Africa*, now from *Dacia* and *Hungary*, and from many places in *England*, eſpecially the foreſt of *Dean*; the other, a factitious ſubſtance of lead burned and quenched in vinegar; in *Pliny*'s time it was made of *Rubrica*, or ruddle burnt. 5. Orpiment, a fat inflammable mineral, juſtly ranked amongſt poiſons, on account of its extreme corroſive quality; *Pliny* ſays, it was dug up in *Syria*, not very deep in the earth, and that the emperor *Caligula* had hopes of obtaining gold out of it; on which account he cauſed 14 pounds of it to be tried, which afforded very good gold, but in ſo ſmall a proportion, that he loſt by the trial. 6. Umber is a native earth. 7. Red-lead, a colour unknown to the ancients, made of litharge, or burnt lead, by a reverberatory calcination, or of ceruſe put in a platter over the fire, which muſt be continually ſtirred, till it has acquired

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acquired a red-lead colour. 8. Burnt oker is the common yellow oker burnt in the open fire. 9. Cinnabar or vermillion, there are two ſorts of it; *viz.* native, or the minium of the ancients, which is the mineral that yields quickſilver, of which and ſulphur it chiefly conſiſts; it is found in the mines of *Iſtria:* This colour was amongſt the ancient *Romans* uſed for ſacred purpoſes, and on feſtivals, *Jupiter*'s face was painted therewith, as alſo the bodies of thoſe who entred in triumph: The factitious cinnabar is that now uſed, and is made by a ſublimation of mercury and ſulphur. 10. Carmine made of cochineel. 11. Lack, thought to be an *Arabic* word, is made of dyed flocks, or ſhavings of ſcarlet-cloth, or of the cochineel-inſect, or elſe of kermes-berries, by extracting their tincture with a lee of pot-aſhes, and then precipitating it with a ſolution of rock-alum: After the ſame manner a lack may be made of any plant or flower; there is another ſort of lack made of gum-lac, by extracting its tincture with urine. 12. *Sanguis Draconis* is the gum of a tree, which looks like dried blood, it is brought from ſeveral parts of the *Eaſt-Indies.* 13. *Engliſh* reddle or ruddle, is found in many places of *England*; particularly, near *Witney* in *Oxfordſhire.* 14. Lamp-black is thus deſcribed by *Pliny* to be made of the ſoot of roſin or burnt pitch; houſes, being built on purpoſe for it, to keep in the ſmoke.

A Voyage of the Emperor *of* China *into the Eaſtern* Tartary. Phil. Tranſ. N° 180. p. 39.

THE emperor of *China* made a voyage into the eaſtern *Tartary* in the beginning of 1682, after having quelled a revolt by the death of three rebellious kings, formed in ſome provinces of the empire: One of theſe princes was ſtrangled in the province of which he had made himſelf maſter; the ſecond, being brought to *Pekin* with the principal heads of his faction, was cut to pieces in the ſight of the whole court; the moſt conſiderable *Mandarins*, acting with their own hands in this ſad execution, to revenge upon this rebel the death of their parents, whom he had cauſed to be cruelly murdered; the third, who was the moſt conſiderable, and indeed the head of the revolt, had, by a voluntary death, prevented his deſerved puniſhment, and ſo put an end to a war, which had laſted for ſeven years: Peace having been ſettled, by the re-eſtabliſhing, in the empire and all its provinces, the peaceable enjoyment of their ancient liberties, the emperor departed the

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the 23d of *March* to go into the province of *Leaotum*, the country of his anceſtors, with a deſign of viſiting their ſepulchres, and, after honouring them with the uſual ceremonies, of proſecuting his journey to the *Eaſtern Tartary:* This journey was from *Pekin* to the end of it about 1100 miles: The emperor took with him his eldeſt ſon, a young prince of ten years of age, who already had been declared heir of the empire: The three principal queens went alſo this journey, each in her gilded chariot, as alſo the principal kings, which compoſe this empire, together with all the grandees of the court, and the moſt conſiderable *Mandarins* of all the orders; who, having all a great train of attendants, and a very ſplendid equipage, made a court about the emperor of more than 70000 perſons: It was the emperor's will, that the author of this relation ſhould accompany him in his journey, and that he ſhould be always near his perſon, in order to make, in his preſence, the obſervations neceſſary for knowing the diſpoſition of the heavens, the elevation of the pole, the magnetical declinations of every place and for meaſuring with mathematical inſtruments the height of the mountains, and the diſtances of places; the emperor was alſo pleaſed to be informed of what concerned meteors, and many other phyſical and mathematical matters; inſomuch that he gave orders to an officer to carry upon horſes ſuch inſtruments as there ſhould be occaſion for, and he recommended the author to the prince his uncle, who was alſo his father in law, and the ſecond perſon of the ſtate, and denominated by a *Chineſe* name, which ſignifies an aſſociate in the empire.

In this journey they always proceeded towards the north-eaſt; from *Pekin* to the province of *Leao-tum*, the road, which is pretty equal, was about 300 miles; the province of *Leao-tum* itſelf is about 400 miles, but the road much more unequal on account of the mountains; from the frontiers of this province to the city of *La*, on the river, which the *Tartars* call *Songoro*, and the *Chineſe*, *Sumhoa*, the way, which is about 400 miles, is very difficult, being ſometimes croſſed by mountains extremely ſteep, ſometimes by valleys of extraordinary depth, and thro' deſart plains for two or three days; the mountains of this country are covered on the eaſt-ſide with great oaks, and old foreſts, which have not been cut for ages: All the country beyond the province of *Leao-tum* is exceeding deſart, and nothing to be ſeen on all ſides but mountains and valleys, and dens of bears, tigers and other beaſts of prey; ſcarcely a houſe to be found, but only ſome poor reed-hutts by the ſides of brooks and ſtreams: All the cities and towns in the province of *Leao-tum*, and which are in great numbers, are entirely ruinous; for the petty king of the *Tartars*, who ſet this war on foot, having but a very ſmall army, cauſed the inhabitants of thoſe places to take arms, and forthwith to deſtroy theſe towns, that he might take from his ſoldiers the hopes of ever returning again to their own homes: The capital of *Leao-tum*, which is called *Xin-Yam*, is a city very fair and pretty entire, it has ſtill the remains of an ancient palace; its latitude is about 41° 56′; in it no declination of the magnetic needle is obſerved: The city of *Ula*, which was almoſt the extremity of this journey, lies in 44° 20′, and there the compaſs declines from the ſouth to the weſt 1° 40′: From *Pekin* towards the eaſt there is made a new road, by which the emperor may commodiouſly march with his horſe, and the queens travel in their chariots; this way is about 10 foot broad, and as level and ſtreight as poſſible, it extends above 1000 miles, it hath a little riſing on each ſide about a foot high, every where equal and perfectly parallel to each other; and this way was as neat, eſpecially when the weather was fair, as a floor where the husbandmen threſh out their corn in the field; there were alſo certain perſons, who all along took care to ſmooth and cleanſe it: There was made, for the emperor's return, a road like the former, mountains were levelled, and bridges raiſed over rivers; and for ornamenting them, they had extended on each ſide of them a ſort of matts, on which divers figures of animals were painted, which had the ſame effect with tapeſtry hangings: The emperor ſeldom made uſe of this way, being generally taken up with the diverſion of hunting; and when he accompanied the queens, he only rid by the ſide of it, that the great numbers of horſe in his train might not ſpoil it; he ordinarily marched at the head of this army; the queens followed immediately, but at ſome diſtance, in their chariots, with their train and equipage; the kings, the grandees of the court, and the *Mandarins*, every one according to his rank, followed the queens; and a great number of attendants, and other people on horſe-back brought up the rear: As there was not one city on all this road, that could either lodge ſo great a multitude, or furniſh them with proviſions, ſo they were obliged to carry along with them neceſſaries for the journey, and even proviſions for three months: On this account there were ſent before, by the roads made on each ſide of that of the empe-

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emperor's, a great number of waggons, camels, horſes and mules for carrying the baggage; beſides theſe, the emperor, kings, and almoſt all the grandees of the court, had great numbers of horſes for relays, and droves of beeves, ſheep, and other cattle; and tho' they marched at a good diſtance from the emperor, yet they raiſed thick clouds of duſt, ſo that it was hard to diſtinguiſh any one at 15 or 20 paces: The march was ſo well regulated, that this army encamped every night on the banks of ſome river or brook; and for this reaſon the tents and baggage neceſſary for this incampment ſet out very early in the morning; and the quarter-maſters, on their firſt arrival, marked out the propereſt ground for the tents of the emperor, queens, kings, grandees of the court, and of the *Mandarins*, each according to his dignity, and according to his ſtation in the *Chineſe* militia, which is divided into eight orders or ſtandards: In the ſpace of three months, they marched about 1000 miles, advancing towards the north-eaſt, and about as many in their return; in fine, they arrived at *Kam-Hay*, a fort ſituated between the *South Sea* and the mountains of the north; it is here the celebrated wall begins, which divides the province of *Leao-tum* from that of *Pekely*, from whence it extends very far northwards, over the tops of the higheſt mountains: Upon entring this province, the emperor, the kings, and the grandees of the court quitted the great road, to take that of the mountains of the north, which are extended without interruption towards the north-eaſt; there, ſome days were ſpent in hunting, which was performed in this manner: The emperor choſe 3000 men of his life-guard, armed with arrows and javelins, and diſpoſed them in ſuch a manner that they took up a great compaſs, making a kind of circle, whoſe diameter was at leaſt 3000 paces; then drawing nearer to each other, without quitting their ranks, the emperor joining with them ſeveral of the captains, and of the grandees of the court, for the better keeping of order, they reduced this great circle to another much leſs, about 300 paces in diameter; ſo that all the beaſts that were encloſed in the firſt, found themſelves taken in this laſt as in a net; for the men ſtood ſo cloſe together that they left no meſhing place for them to eſcape; then they purſued them ſo vigorouſly in this ſmall compaſs, that the poor animals, tired with the violence of their courſing, came and fell down at the feet of their chaſers, and ſuffered themſelves to be taken without any trouble; the author had ſeen two or three hundred hares taken in this manner in leſs than one day, beſides a great number of wolves and foxes: After having travelled about 400 miles in hunting in this manner, they arrived at laſt at *Xyn-Yam*, the capital of the province; during his ſtay in this city, the emperor, with his queens went to viſit the ſepulchres of his anceſtors, which are at a ſmall diſtance from this place, from whence he ſent back the queens to *Xyn-Yam*, to continue his own journey into the *Eaſtern Tartary:* After ſeveral days marching and hunting, he arrived at *Kirin*, 400 miles from *Xyn-Yam*; this city is built along the great river *Songoro*, which takes it ſource from the mountain *Cham pe*, diſtant 400 miles towards the ſouth; this mountain, ſo famous in the eaſt, for having been the ancient ſeat of the *Tartars*, is always covered with ſnow, whence its name, *Cham-pe* ſignifying the white mountain: As ſoon as the emperor ſaw it, he alighted from his horſe, and fell down on his knees on the bank of the river, and bowed himſelf three times to the ground to ſalute it; after which, he cauſed himſelf to be carried on a glorious throne of gold, and thus he made his entrance into the city; all the people ran in throngs before him, teſtifying by their acclamations, the joy they had to ſee him; this prince took great pleaſure in thoſe teſtimonies of their affections, and to give them ſome marks of his being very ſenſible thereof, he was pleaſed to ſuffer himſelf to be ſeen by all, and forbid his guards to hinder the people from approaching him, as they uſed to do at *Pekin:* In this city there are barks of a particular conſtruction; the inhabitants do always keep a great number of them in readineſs to repulſe the *Muſcovites*, who come often into this river, to diſpute the fiſhing of pearls: The emperor repoſed himſelf for two days, and after that he went down the river, accompanied with more than 100 boats, till he arrived at the city of *Ula*, the faireſt in all this country, and which formerly was the ſeat of the empire of the *Tartars:* A little below this city, which is at moſt about 32 miles from *Kirin*, the river abounds in a certain fiſh, which reſembles pretty much the plaice of *Europe*; and it was principally to take the diverſion of fiſhing that the emperor went to *Ula*; but the rains, coming on ſo ſuddenly, ſwelled the river ſo much, that all their nets were broken and carried away: And in their return to *Pekin* they underwent infinite fatigues, the roads having been ſpoiled by the rains and rendred almoſt impaſſable, there being in ſeveral places great collections of water and mud; the bridges were either overturned by the violence of the currents, or covered all over by the overflowing of the waters: The author underſtood from the inhabitants of *Ula*, that *Nincrita*, a place much renowned in thoſe parts, is diſtant from *Ula* 700 *Chineſe* ſtadia, each of which is 360 geometrical paces, and that imbarking at *Nincrita* upon the great river *Heleum*, into which the *Songoro*, and ſome other more conſiderable rivers do diſcharge themſelves, and following the courſe of the river, which runs towards the north-eaſt, or ſomewhat more to the north, they arrive in 40 days at the *Eaſtern Sea*, which is probably the ſtreights of *Anien*.

A Voyage of the Emperor *of* China *into the* Weſtern Tartary. Phil. Tranſ. N° 180. p. 52.

THE emperor in 1683 made a journey into the *Weſtern Tartary*, together with the queen his grand-mother, called the queen-mother; he ſet out the 16th of *July*, attended with more than 60000 men and 100000 horſes; there were ſeveral reaſons for undertaking this journey: The firſt was, to keep his militia, both in peace and war, in continual exerciſe; and for this reaſon it was, that after he had eſtabliſhed a firm peace in all parts of this vaſt empire, he recalled his beſt troops from every province, and reſolved in his council to make every year, expeditions of this ſort; that by hunting of deer, boars, bears and tigers, they might learn to overcome the enemies of the empire, or at leaſt to prevent the cooling of their courage, or their degenerating from their priſtine valour, by the luxury of *China*, in a long tract of peace: In effect, theſe hunting matches had more of the ſhew of a military expedition, than of diverſion; they were all armed with arrows and ſcimeters, divided into companies, and marched in battle-array after their ſtandards, with the ſound of drums and trumpets; during their hunting, they entirely inveſted the mountains and foreſts, as if they had been cities, which they deſigned to beſiege; imitating, in this, the manner of hunting of the *Eaſtern Tartars*: This army had its van and rear guards, its main body, its right and left wings, which were commanded by ſo many generals, and petty kings; more than 70 days were ſpent, before they ſet forwards on their march, in making proviſion for the army; for in all the *Weſtern Tartary*, ſo called not in reſpect of *China*, which is itſelf weſtward of it, but in reſpect of the *Eaſtern Tartary*, there is nothing to be found but mountains, rocks and vallies, there are neither cities, towns or villages, nor ſo much as any houſes;

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houſes; the inhabitants lodge under tents, pitched on all ſides in the open fields; they are generally ſhepherds, and tranſport their tents from one valley to another, according as they find paſture; they breed no hogs, nor any of thoſe animals, which elſewhere are fed in villages, as poultry and geeſe; but only ſuch as feed on herbs produced in an uncultivated country; they paſs their lives, either in hunting, or doing nothing at all; and as they neither ſow nor cultivate their land, ſo they have no harveſts; they live on milk, cheeſe and fleſh, and have a ſort of wine, not unlike our *Aqua Vitæ*, with which they make merry and are often drunk; in a word their greateſt care is, what to eat and drink, like the beaſts and droves they feed: They are not without their prieſts, whom they call *Lamas*, and for whom they have a great veneration; and in this they differ from the oriental *Tartars*, the greateſt part of whom have no religion, nor any belief of a God; for the reſt, both the one and the other are ſlaves, and wholly depend on the will of their maſters, whoſe religion and manners they blindly follow: This part of *Tartary* lies without the prodigious *Chineſe* wall about 1000 ſtadia, that is, more than 300 *European* miles, and extends from the north-eaſt towards the north: The emperor rides on horſe-back, at the head of his army, thro' thoſe deſarts, and ſteep mountains, far from great roads, expoſed all day to the heat of the ſun, to rains, and all the injuries of the weather: The ſecond reaſon of undertaking this journey was to keep the *Weſtern Tartars* in their allegiance, and to prevent any pernicious deſign formed againſt the ſtate: It was for this reaſon, that he entred their country with ſo great an army, and with ſuch warlike preparations; and that he cauſed at ſeveral times great guns to be diſcharged, to ſtrike terror into the rout: Beſides this great retinue, he would ſtill be accompanied with all the marks of grandeur of the court of *Pekin*; *viz.* with a number of drums, trumpets, timbrels, and other muſical inſtruments; which formed concerts, either whilſt he ſat at table, when he entred the palace, or when he went out; that by this external pomp he might aſtoniſh this barbarous people, and inſpire them with the fear and reſpect of his imperial majeſty; for the empire of *China* never had any enemies more formidable than theſe *Weſtern Tartars*; who begin from the eaſt of *China* to encompaſs it with an almoſt infinite number of people, and keep it, as it were, continually beleagured on the weſt and north ſide thereof; and it was, to make a bulwark againſt their incurſions, that an emperor of *China* in ancient times cauſed this great wall to be built, which ſeparates *China* from their country: The author had paſſed this wall four times, and had conſidered it very attentively, and he thinks he can ſay without exaggeration, that all the ſeven wonders of the world, put together, are not comparable to this work; and that all that fame hath ſaid concerning it is far ſhort of the truth: Two things are more eſpecially remarkable; firſt, that vaſt extent of country from eaſt to weſt, thro' which it paſſes; as in ſeveral places, not only thro' vaſt champaigns; but alſo over the tops of exceeding high mountains, on which it is raiſed by little and little, and fortified at certain intervals, with large towers, not diſtant from each other more than two flight-ſhot; he found its height in a place he meaſured 1037 geometrical feet above the horizon; ſo that it is hard to comprehend, how it was poſſible to raiſe this enormous bulwark to that height, in places dry and mountainous, whither the ſeveral materials, as water, brick and mortar muſt have been brought from a great diſtance with incredible labour: The ſecond thing ſurpriſing was, that this wall is not continued in the ſame line, but bent in ſeveral places, according to the ſituation of the mountains; in ſuch a manner, that inſtead of one wall, one may ſay there are three, which encompaſs this large part of *China*: After all, the *Tartarian* monarch, who united the *Chineſe* and the *Tartars* under one and the ſame government, hath done ſome things, which are more for the ſecurity of *China*, than that emperor who built the long wall; for, after reducing the *Weſtern Tartars*, partly by artifice, and partly by force of arms, he obliged them to remove to the diſtance of 300 miles from the *Chineſe* wall, where he diſtributed lands and paſture amongſt them, and gave their country to other *Tartars* his ſubjects; notwithſtanding which, theſe *Weſtern Tartars* are ſo powerful, that if ever they ſhould unite together, they might make themſelves maſters of all *China*, and of the *Eaſtern Tartary*: One of the principal concerns of this emperor was to engage to his intereſt, by his royal bounties, and by demonſtrations of a ſingular affection, the *Lamas*, or prieſts; for they being in great repute amongſt their own nation, eaſily perſuaded them to ſubmit to the government of ſo great a prince; and it is in conſideration of this ſervice, that the preſent emperor looks on the *Lamas* with a favourable eye, that he beſtows preſents on them, and that he makes uſe of them to keep the *Tartars* in their allegiance: This vaſt country is divided into 48 provinces;

vinces; whence it is, that the emperor of *China* may be juſtly called the greateſt and moſt powerful monarch of *Aſia:* The preſent emperor has charged himſelf with the whole government, without ſharing any part of it with any of the *Colaos*, or any of the great men of his court: He puniſhes with extraordinary equity both high and low; he deprives them of their charges, and degrades them from the rank they held, proportioning always the puniſhment to the heinouſneſs of the crime; he takes cogniſance of the affairs tranſacted in the royal council, and the other tribunals; in a word, he diſpoſes of, and orders every thing himſelf; and it is on account of the abſolute authority he hath thus acquired, that the greateſt lords of the court, and perſons of the higheſt quality in the empire, even the princes of the blood, never appear in his preſence, but with the profoundeſt reſpect: The third reaſon the emperor had for this journey, was on account of his health; becauſe he knew by experience, that when he is too long at *Pekin* without going abroad, he cannot avoid falling into ſeveral diſtempers, which he prevents by means of theſe long progreſſes; for during the whole journey, he never ſees any woman; and which is more ſurpriſing, there is not one in all this great army, except thoſe of the retinue of the queen mother; and it is very rarely, that ſhe or any of the queens accompany the emperor in theſe tours: Another reaſon of this journey, was to avoid the exceſſive heats of *Pekin*, in the ſummer, during the dog-days; for in this part of *Tartary* there reigns, during the months of *July* and *Auguſt*, ſo cold a wind, eſpecially in the night, that it is neceſſary to put on thick cloaths and furs; and this extraordinary cold may be owing to the country being high and mountainous, and to the ſaltpetre, in which it alſo abounds; the cold here is ſo violent, that frozen clods, and pieces of ice are dug up at the depth of three or four foot: For a tract of more than 600 miles, the emperor cauſed to be made a great high-way a-croſs mountains and vallies for the queen mother, who rode in a chariot; he built an infinite number of bridges over torrents; and he alſo ordered rocks to be cut thro' with incredible labour and expence.

Obſervations and Conjectures on the Chineſe Characters. Phil. Tranſ. N° 180. p. 63.

WHether there ever was any natural language, the author does not diſpute; but that there have been, ſtill are, and that more artificial languages may be invented, is not hard to prove: The *Chineſe* court-language is ſaid to be of this kind, contrived and ſpoken by the *Literati* and *Mandarins* throughout the whole empire of *China*, and differing from all the other languages ſpoken therein; and he conjectures it to be nothing more than the names of the characters, by which they write and expreſs their meaning, arbitrarily impoſed by them, as we in *Europe* give names to arithmetical figures, and not as we pronounce words written with a literal character; this the author judges, by comparing the characters with the names they pronounce and read them by: Nor do they aſcend above a monoſyllabical name, tho' the character conſiſt of many ſingle ones, each of which hath its proper ſenſe and monoſyllabical name, and tho' the meaning of each character be an ingredient in the notion of that compounded character.

But whatever we may judge of language, it is paſt diſpute, that writing was ever artificial, how anciently ſoever it were uſed, and was the invention of ſome thinking and ſtudious men; it is alſo evident, that there have been various ways thought of for expreſſing ſignificancy, according to the ſeveral genius's of the inventors; as may be gueſſed from the *Egyptian* hieroglyphics, the *Chineſe* characters, the *Mexican* chronology, and the literal characters of ſeveral nations; each of which ſeem to proceed on different methods, and from different turns of invention: Which of theſe methods is the moſt ancient, is hard to prove; the *Egyptian* mummies and obeliſks ſhew the great antiquity of the hieroglyphics; yet the *Chineſe* chronology, if it may be credited, exceeds the *Egyptian* in that reſpect; for the *Chineſe* make *Fohi*, the firſt king of *China*, the inventor of their character, and account him to have lived 2950 years before Chriſt; during all which time they pretend to a written and authentic hiſtory; but their account of the times preceeding that, they eſteem more fabulous, as chiefly depending on fiction and oral tradition; which may be eaſily ſeen from the number of years they reckon ſince the creation to the preſent year 1686, *viz.* no leſs than 88640102 ſolar years; there having expired ſince the creation 8864 *Ven* of years, (every *Ven* contained 10000 ſuch years) and of the preſent *Ven* this year 1686 is the 102d; which account is abundantly more extravagant than the *Egyptian*; but this need not invalidate their hiſtory ſince *Fohi*; by which it appears that their character was invented before *Moſes*, about 1400 years, and even before *Menes*, the firſt *Egyptian* king, about 500 years; ſo that the *Chineſe* characters ſeem to be the moſt ancient of the kind; and the book *Yekim*, ſaid to be written by *Fohi*, the oldeſt book.

Paulus Jovius affirms, that the firſt occaſion of the art of printing in *Germany* was owing to a *German* merchant, who, returning from *China* into his own country, related what he had obſerved concerning the practice of it in that country; and tho' the *Chineſe* way be wholly different, as to the method of compoſing, from what was invented and perfected here in *Europe*; yet ſuch an intimation was ſufficient to an ingenious artiſt to improve the firſt contrivance, and to accommodate it more to the literal way of writing with us; and as our way is now poſſibly brought to the greateſt perfection for exactneſs and expedition, ſo doubtleſs muſt their way of printing; ſince they can ingrave their ſtamp for a ſheet, as ſoon as one of our compoſitors can ſet and correct a ſheet of our literal character; and ſince one man alone may print off 1500 ſheets a-day; tho' it is generally believed to be much the ſame with our wooden cuts for printing; yet from ſome obſervations, hereafter to be mentioned, it ſeems to be quite different.

By a *Chineſe* manuſcript, the author found that the pronounciation had no affinity with the ſtrokes of the characters; whence he conceived it to be either a numeral character, conſiſting of numbers; or elſe a real character, but not a literal, unleſs it were a literal character of ſome other language than that whereby it was pronounced, whoſe pronounciation is loſt, tho' the ſignificancy be retained: Since that time the author had procured from *China* a dictionary of the court-language; but this whole book conſiſted only of the *Chineſe* characters, without any interpretation or pronounciation; however, by the help of the pictures of that, and a *Chineſe* almanac, he ſoon found out their numeral characters, and their way of numeration, together with the figure, and uſe of their *Abacus*, or counting-board, for performing the operations of arithmetic; which he found pretty nearly to agree with that of the ancient *Romans*, ſave only, that inſtead of the pins and ſliding grooves of the *Romans*, the *Chineſe Abacus* hath ſprings or wires, and beads to ſlide upon them; and that, inſtead of four pins for digits, or units, the *Chineſe* hath five beads; whence it ſhould ſeem, that the *Chineſe Abacus* was deſigned for a duodecimal progreſſion, but the *Roman* for a decimal; one thing is remarkable in the *Chineſe*, that the places in the *Abacus* lie horizontal, and the firſt place is next the left hand, which probably was alſo the firſt in their old way of reading: Now as the *Chineſe*

Chineſe and *Roman Abacus* do very much agree, ſave only that they proceed contrary ways, ſo doth alſo their method of expreſſing numbers by letters or marks; one ſtroke, or line, ſignifying *one*; two lines, *two*; three lines, *three*; a croſs, *ten*; two croſſes, *twenty*; three croſſes, *thirty*, and ſo on to a *hundred*, which they expreſs by a ſquare mark; and a croſs with a ſtroke added ſignifies a *thouſand*: And tho' the characters are not all the ſame, yet the order and method of one agrees very nearly with that of the other; eſpecially if it be allowed, that the primitive way of writing and reading with the *Chineſe* was horizontal, like the *European* way.

Having thus diſcovered their numeral characters, and their way of numeration, the author applied himſelf to underſtand ſomething of their language and character; and upon peruſing all the accounts he could meet with in books, he found very little ſatisfaction, as to what he enquired after; which was, firſt, concerning the method of their character, whether it conſiſted of a certain number of marks methodically diſpoſed like letters in a literal, or like numbers in a numeral, or like radicals incompoſite and decompoſite derivations: This character is ſaid to be legible in a great many languages, conſiderably different from each other; but how this is effected, is not related, only it is ſaid that the marks are of the nature of arithmetical figures, which are become almoſt univerſal, at leaſt here in *Europe:* Secondly, as to the number of theſe characters, he found as little ſatisfaction; ſome making them 120000, others 80000, and others again 60000; and that it is neceſſary for a man to remember, write, and read at leaſt 8000, or 10000, before he can expreſs his meaning thereby; and that it is the buſineſs of a man's whole life to be thoroughly intelligent in the whole character; which ſeems to intimate that the characters are immethodical, and that there are as many primitive characters as words: Others tell us of various kinds of characters, which have been in uſe in ſeveral ages; the firſt, they ſay, were hieroglyphical, like the *Egyptian* or *Mexican*, conſiſting of pictures of animals and vegetables; but the *Chineſe* conſiſt of lines and points, there being no ſuch thing, as letters or ſyllables, but every diſtinct word and notion hath a diſtinct character, and they are all primitive or incompoſite; which accounts do ſeem to inſinuate that this character is the moſt difficult, and the moſt perplexed piece of learning in the world, and depends wholly upon the ſtrength of memory in retaining their form and ſignification; but the author, from his

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his own obſervations, ſeems to doubt of the juſtneſs of theſe accounts: For in the firſt place he obſerved, that every one of their characters, whether conſiſting of more or fewer ſtrokes, were compriſed within a certain ſquare ſpace, which is proportioned according to the bigneſs of the ſize or manner of writing, they deſign to uſe; not that the whole ſquare is filled with every character, only no part of that character exceeds the limits of its ſquare; ſo that their characters are exactly ranged in rank and file, not unlike our numbers in arithmetic: Yet on ſeveral occaſions they vary the bigneſs of their character, as in the titles of books, chapters, or ſections, *&c.* And he alſo met with three ſeveral kinds of characters; the moſt uſual is the fixed, or ſet ſquare form; the ſecond ſort is the running hand, in which the orders of the court are written, whereof he had ſeen three or four ſorts, in which the pencil is never taken off, till the whole character be finiſhed, and ſometimes two or three are all written without break; the third ſeems to be, ſomewhat like the flouriſhing great letters uſed by ſcriveners at the beginning of deeds, and by the *Germans* at the beginning of chapters and ſections; they are compounded of the ſame ſtrokes, as the ſet character, but ſhaped a little different, that they may appear the more beautiful and regular; this third is made uſe of for epitaphs, and other inſcriptions on buildings or monuments: Theſe three ſorts may be called the three general kinds of writing; but there is almoſt an infinite variety of forms, as will appear by conſidering that the printed characters are exactly the ſame with the written; inſomuch that every variety in each ſtroke, line, or point, made with the pencil, is perfectly expreſſed in the impreſſion; and the form, mode, or hand of every writer is exhibited ſo curiouſly, that it is hardly poſſible to be performed after the way of wooden cuts, as authors affirm it is, but it muſt be done in the manner of our copper cuts, printed by a rolling-preſs: Their paper is generally very thin and fine, and very tranſparent, but brown; ſo that whatever is written or printed on it, is almoſt as eaſily read on the back as on the fore-ſide, which is of great uſe in the cutting of their ſtamps; and hence they never write on both ſides of the ſame leaf, but only on one ſide; and to make the leaf appear printed on both ſides, they double the ſheet, with the printed ſides outwards, and putting the folded part forwards, they ſow, bind, or ſtitch together all theſe ſheets by the cut edges, and upon whole ſheets, inſtead of ſingle leaves: They begin the book on the top of the right hand ſide of the page, and they read downwards to the bottom, then they begin the next line towards the left hand at the top, and ſo read to the bottom, and thus they proceed to the end of the book: The title of the book is ſet firſt on a whole leaf, uſually of a thicker paper, and ſome title is likewiſe written on the folding or edge of every ſheet, where is alſo ſet the number of the book, and that of the ſheet, half of which appears on one ſide, and half on the other of the fold: As to the character itſelf, each of them is made up of a certain number of ſtrokes, lines, or marks, which are very diſtinct from each other, in their ſhape and poſition; and becauſe theſe are ſingle ſtrokes, they may be called the letters, elements or particles, out of which the more compounded characters are made up; theſe are the firſt kind, and of which there are but a very few: Two, three, four, or more of theſe joined together in a certain order and contexture (in the doing of which, a great regularity is obſerved, and all within the ſquare ſpace) make up ſyllables, or primitive radical characters, each of which have a primitive, ſingle, or diſtinct notion, or ſignification, as well as ſound, which is much uſed in the more compounded characters or words; of this kind the numeral characters are taken to be; and of this ſecond ſort, there are about 500: The third ſort of character is a decompounded ſpecies, conſiſting of two, three, or more of thoſe of the ſecond kind, diminiſhed proportionably in their ſize, either as to their length, breadth, or both, from what they have in the ſame writing, when they are ſingle, and fill up the whole letter-ſquare, or word-ſquare: This method alone of crouding together all the characters of a decompounded one into one ſquare, which is of the ſame ſize both for the moſt ſimple and the moſt compounded, ſeems to be the peculiar difference of the *Chineſe* characters from thoſe of all the reſt of the world; and this poſſibly is the reaſon, why they are taken for real, not literal characters; for if the primitive language, or pronounciation of the characters be loſt, and the diſpoſition, order, method, texture, or manner of placing the more ſimple in the more compounded characters be alſo loſt, or not underſtood, then the whole characters become a real, and not a literal character: But this author conceives it might be at firſt, either a literal character, and ſo the whole ſquare character be compoſed of ſo many diſtinct letters, or ſyllables, which conſtituted the word ſignified thereby; and ſo there might be a regular order of placing theſe letters in the characters; that is, that the whole ſquare being divided into ſo many parts, there was a rule for finding, which was 1ſt, 2d, 3d, and 4th place; ſo that the ſeveral letters, that made up the word, being placed in thoſe, according to the order they had in the word, it was eaſy, by that rule, to decipher the ſaid character, and thence find the word and its ſignification, as regularly as if the letters had been written one after another, like all other literal characters: Or, ſecondly, it might be a real character, conſiſting of ſeveral ſtrokes or letters, that expreſſed ſo many ſimple notions, ſeveral of which joined together might make up the more compounded characters.

The preſent uſe of this character ſeems to differ from what it was at firſt, both as to the poſition of writing and reading it, and as to the expreſſion and pronounciation thereof; for the way of writing and reading it, might at firſt be exactly the ſame with the *European*; that is, they might begin at the top of the page towards the left hand, and ſo proceed towards the right in the horizontal line to the end of it; then beginning at the left end of the next line under the firſt, and ſo on, till the whole was finiſhed, they joined leaf to leaf, one under another, after the ſame manner as the rolls are at preſent writ, and as the *Volumina* of the ancients were; and that the parts of the volume might be more eaſily come at, without the trouble of the rolling and unrolling, they contrived to fold them like a fan, forwards and backwards, ſtitching them together in ſuch a manner, that the written ſides might lie outwards, and open freely from each other, and that the fair ſides might meet together; it came to make the preſent form of their books, which being laid, as we generally place our books before us, they ſeem to begin at the top of the page on the right hand, and to proceed to the bottom, and then at the top of the next line towards the left hand, and deſcend as in the former; proceeding in this order with all the reſt: Secondly, as to the pronounciation of this character by the court-language, or by any other now uſed, this author conceives it to be wholly different from that of a literal character, that is, from being pronounced, or ſpoken, according to the marks or figures thereof, whether ſimple or compounded: The reaſon of which different pronounciation may have proceeded partly from the loſs of the primitive language, for which it was deſigned, partly from an affectation of monoſyllabical words in this court-language; to help out the poverty of which, they are fain to make one ſyllable to ſignify many different notions; to do which, they have introduced a kind of muſical toning or accenting of each of them, and that not ſingle, but compounded of two or three tones to each ſignification of every one of theſe monoſyllables; and this different pronounciation ariſes alſo from this way of writing having been uſed by divers nations of different languages; who minding only the figure and ſignification, read it in their own mother-tongues, as we in *Europe* do arithmetical figures; and partly alſo from the omiſſion of moſt grammatical diſtinctions, the ſame character ſerving for ſubſtantive and adjective, ſingular and plural in all caſes, for the verb in all tenſes and numbers, *&c.* for the abſtract and concrete ſignification; partly alſo from their ſyntax, it being neceſſary to conſider the whole ſentence, in order to diſcover which part of ſpeech each character is of, in that ſentence; wherein the order and poſitions of the characters to each other, for which they have rules, have their ſignificancy; and laſtly, from the loſs of the very notion of a literal character; whence for the expreſſing of proper names, they are fain to make uſe of ſeveral characters, whoſe ſounds or words come neareſt to the ſounds of the ſyllables of that name, as *tam, jo, van,* for *Adam Jovan.*

Now, tho' the author conceives this character not to be effable, properly as a literal character, by any of their preſent languages; and tho' poſſibly it might be at firſt a real character, that is, each of them compounded of ſuch ſtrokes or marks, as by their figures, poſitions, and numbers in the ſquare, denoted the ſeveral philoſophical ingredients, that made up the notion of the whole character, as the book *Ye-kim* ſeems to ſhew, by giving rules, for the order and ſignificancy of places in the ſquare, *&c.* yet he thinks it not difficult to make it a literal, or at leaſt a ſyllabical character, and legible into a language, ſomething after the manner of the univerſal character invented by biſhop *Wilkins*; wherein the ſingle characters might be monoſyllables, and the compounded, diſſyllables, triſſyllables, *&c.* according to the number and order of ſimple characters in the ſquare of the compounded.

Of an Engine *that conſumes* Smoke; *by M.* Juſtel. Phil. Tranſ. N° 181. p. 78.

M. *Daleſme* hath invented a machine, which, tho' very ſmall and portable, conſumes all the ſmoke of all ſorts of wood whatever; and that in ſuch a manner, as that the moſt curious eye cannot diſcover it in the room, nor the niceſt noſe ſmell it, altho' the fire be perfectly open: This machine conſiſts of ſeveral hoops of hammered iron, of about four or five inches diameter, which ſhut into each other; it ſtands upright in the middle of the room on a ſort of trevet made on purpoſe; A Fig. 2. Plate XI. is the place where the fire is made, and where if you put little pieces of wood, there will not be the leaſt ſmoke, either at A or B, over which you cannot hold your hand within half a foot, becauſe of the great heat; if you take one of theſe pieces of wood out of the fire, at A, it ſmokes preſently, but ceaſes immediately, as ſoon as it is caſt into the fire again; the moſt fœtid things, in this machine, do not produce the leaſt ill ſcent, and all perfumes are loſt therein; which only happens, when the fire at A is well kindled, and the tunnel B D very hot; ſo that the air, which feeds the fire, cannot come that way, but muſt all preſs in upon the open fire; whereby the ſmoke and flame are all forced inwards, and made to paſs thro' the heap of burning coals in the furnace A; in which paſſage its parts are ſo diſperſed and refined, that they become inoffenſive both to the eye and noſe.

The two interior Satellites *of* Saturn *diſcovered*; *by* M. Caſſini. Phil. Tranſ. N° 181. p. 10.

THE firſt or innermoſt ſatellite of *Saturn*, by the obſervations hitherto made, is never diſtant from his ring, above $\frac{2}{3}$ of the apparent length of the ſame ring, which is taken for the meaſure of the diſtances of theſe ſatellites; and it makes one revolution about him, in one day, 21 hours and 19 min. wherefore in leſs than two days, it makes two conjunctions with *Saturn*, the one in the upper part of his orbit, and the other in the lower; and the ring taking up the greateſt part of the diameter of the orbit, wherein this ſatellite makes its revolution, theſe conjunctions are of a long continuance, in reſpect of the whole revolution, it being eight hours and a half and ſometimes more, in paſſing the length of the ring: This happens particularly, when the poſition of the ring, in reſpect

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of the earth, being very oblique, the ring appears very narrow, and the orbit of this ſatellite being nearly in the ſame plane therewith, they both appear very cloſe together; but when the ring and the orbits of theſe ſatellites are more open, there is a greater diſtance in latitude between this ſatellite and the ring, and it may be ſeen both above and below the *Anſæ*.

The ſecond ſatellite of *Saturn* is but ¾ of the length of his ring diſtant therefrom, and makes his revolution about him in 2 days 17 hours and 43 minutes.

After a great number of accurate obſervations, it was concluded, that the proportion of the digreſſions of the ſecond to that of the firſt, reckoning from the centre of *Saturn*, is as 22 to 17; and the time of the revolution of the ſecond to that of the firſt as 24 ¾ to 17; which is that very proportion, *Kepler* obſerves between the diſtances and periods of the primary planets, and which takes place in the other ſatellites of *Saturn*, and is alſo verified in the ſatellites of *Jupiter*; which plainly ſhews the admirable harmony of the particular ſyſtems with the great ſyſtem of the world.

Of all the ſatellites, there are none ſo near their primary planet, as theſe two ſatellites of *Saturn*, and which, taken both together, make ſo great a number of conjunctions with their planet in the ſame ſpace of time; for there are no leſs than 653 in a year; whereas the two firſt ſatellites of *Jupiter* make, one with another, but 617.

Theſe two ſatellites were firſt of all ſeen *March* 1684 by two excellent object glaſſes of 100 and 136 foot; and afterwards by two others of 93 and 70 foot; it was eaſy to ſee theſe two ſatellites thro' theſe different ſorts of glaſſes, after having once found the rules of their motion; for thereby the eye might with more particular attention be directed towards the places, where they ought to be.

The *Radices* or *Epochæ* of their motions were theſe; *viz.* the firſt ſatellite was obſerved 45 degrees diſtant from it *Perigæum*, moving towards the weſt, *March* 11th, 1686 N. S. at 10 h. 40 min. at night; and was returned to the ſame poſition on the 14th of *April* at the ſame hour: The ſecond was 30 deg. diſtant from the *Perigæum* to the weſt, the 30th of *March* 1686 N. S. at 8 o'clock in the evening.

By a compariſon of the revolutions of *Saturn*'s ſatellites with thoſe of *Jupiter*, it appears that the former, in the ſame order, perform their revolutions in leſs time, than thoſe of *Jupiter*, anſwering to them, excepting the firſt.

	d.	h.	m.
The firſt ſatellite of *Jupiter* revolves in —	1	18	29
———— of *Saturn* in — —	1	21	19
The ſecond of *Saturn* in — — —	2	17	43
———— of *Jupiter* in — — —	3	13	19
The third of *Saturn* in — — —	4	12	27
———— of *Jupiter* in — — —	7	4	0
The fourth of *Saturn* in — — —	15	23	15
———— of *Jupiter* in — — —	16	18	5

As the ancients had given the names of their heroes to the ſtars, and *Galileo*, after their example, had honoured the houſe of the *Medici* with the diſcovery of the ſatellites of *Jupiter*, which he made under the protection of *Coſmus* II. calling them *Sidera Medicea*; ſo in like manner M. *Caſſini*, to perpetuate the name of *Louis le Grand* with a monument more laſting than that of braſs or marble, gave the ſatellites of *Saturn* the appellation of *Sidera Lodoicea*.

Why Bodies diſſolved in Menſtrua *ſpecifically lighter than themſelves ſwim therein; by Mr.* Will. Molyneux. Phil. Tranſ. N° 181. p. 88.

WHY bodies, diſſolved, float in liquors lighter than themſelves; as for inſtance, why mercury, diſſolved in ſtrong ſpirit of nitre, ſwims therein, tho' each ſmall particle of mercury be far heavier than ſo much of the liquor, whoſe place it poſſeſſes; is a problem, Mr. *Thomas Molyneux* thinks, cannot be ſolved by the prime law of hydroſtatics; which is, that a body, bulk for bulk heavier than a liquor, ſinks in that liquor; thus a cubic inch of iron, being heavier than a cubic inch of *Aqua Fortis*, and put into it, ſhould ſink; and yet we find, that iron, diſſolved in a convenient quantity of *Aqua Fortis*, floats therein, and does not fall to the bottom; and the reaſon he gives for this phænomenon is, that the internal motion of the parts of the liquor ſuſtains the particles of the diſſolved ſolid; for being ſo very minute, they are moveable by the leaſt force imaginable, and the action of the particles of the menſtruum is ſufficient to drive the atoms of the diſſolved ſolid body from one place to another; and conſequently, notwithſtanding their gravity, they do not ſink in a liquor lighter than themſelves; as a proof of this he offers a known experiment in chemiſtry; *viz.* that a menſtruum over a digeſting fire will diſſolve a greater quantity of a body, than when it is off the fire, and if ſuffered to cool, a great deal of that, which was diſſolved, will precipitate; for according to him the particles of the menſtruum acquire a more violent agitation by the fire, and are therefore able to ſuſtain a greater quantity of the diſſolved body, or reſiſt a greater gravity: To this it has been objected, that the common experiment of precipitation, by mixing an alcali with an acid ſeems to contradict this; for, thereby the fluidity of the menſtruum is not deſtroyed, and conſequently the internal agitation of its parts is not diminiſhed, and yet the particles of the diſſolved body do precipitate to the bottom; to this he anſwers, that all mixtures of different liquors introduce in each a different conformation of pores, and therefore the infuſion of a new liquor drives the inſenſible parts of the diſſolved body from their places, and forces them to ſtrike againſt each other, and cling together, and ſo becoming larger and heavier than formerly, the internal agitation of the liquor is no longer able to move and ſuſtain them, and conſequently they fall to the bottom.

But Mr. *William Molyneux* is of opinion, that another account may be given of this appearance, and that the abovementioned law of hydroſtatics is ſomething defective: It is true indeed, if we conſider only the ſpecific gravity of a ſolid particle floating therein, the abovementioned rule is juſt, but in ſinking, there is requiſite a ſeparation of the parts of the liquor by the ſinking body; and there being a natural inclination in the parts of all liquors to union, ariſing from an agreement or congruity of their parts, they reſiſt every thing that would attempt a ſeparation; now unleſs a body have weight ſufficient to overcome this congruity or union of parts, ſuch a body will float in a liquor ſpecifically lighter than itſelf: But that a heavy body, as mercury or iron, may have its parts reduced to that minuteneſs, as that their gravity or tendency downwards is not ſtrong enough to ſeparate the coheſion or union of the parts of a liquor, will be manifeſt from conſidering, that the reſiſtance, made by the medium to a falling body, is in proportion to the ſurface of the body; but its decreaſe of ſurface is not proportionable to its decreaſe of bulk; thus a ſphere of an inch diameter has not eight times leſs ſurface than a ſphere of two inches diameter, tho' it have eight times leſs bulk; and conſequently paſſing thro' a medium, as ſuppoſe air or water, the ſphere of one inch diameter is, proportionably to its bulk, more reſiſted, than a ſphere of two inches diameter in proportion to its bulk; and hence it will be, that at laſt a body may be reduced to that minuteneſs, as that its gravity, preſſing downwards, may be leſs than the reſiſtance of the medium, which operates on the ſurface of the body, ſeeing, as was ſaid, the ſurfaces of bodies do not decreaſe ſo faſt as their bulks, theſe decreaſing in a triplicate, but thoſe in a duplicate ratio of the diameters of the bodies: But becauſe it was ſaid that the abovementioned law of hydroſtatics is a little defective, he explains himſelf a little further on that head; *viz.* that in weights falling thro' the air, were gravity only conſidered, the proportions of their deſcents would be exactly as *Galileo* has demonſtrated; but it is univerſally allowed, that, the reſiſtance of the air being diſregarded in theſe demonſtrations, they are not mathematically true: Were a piſtol-bullet let fall thro' the air, it would deſcend nearly according to *Galileo*'s proportions, but were a ſingle grain of ſand let fall, it would be much hindred in its courſe, and the half of this grain much more ſo; what ſhall we then ſay of the ten thouſandth part, or of a part the ten thouſand millionth of this, and again of the infinite ſubdiviſions of that, till at laſt we come to a part that would be wholly reſiſted, or ſuſtained; ſuch as the minute particles of a body, diſſolved in a menſtruum, are: And on this account it is, that the abovementioned principle of hydroſtatics is a little defective; for it does not conſider the natural congruity of the parts of a liquor, whereby they unite and keep together; and therefore liquors have an inherent power of reſiſting a certain degree of force that would ſeparate them; ſuch as is ſuppoſed the degree of gravity in the moſt minute particles of a body diſſolved in a menſtruum: However Mr. *Molyneux* would not be thought to reject the other ſolution of this problem; for that motion in a menſtruum, which is capable of diſſolving ſuch a ſolid body as iron, that is, which is, capable of diſturbing the cloſe and ſtrong coheſion of the parts of iron, may very well be ſuppoſed ſufficient to ſuſtain thoſe parts in the veſſel, wherein the ſolution was made; and certainly no better account can poſſibly be given of ſuch ſolutions, than by ſuppoſing ſuch an internal motion in the parts of the menſtruum, whereby they inſinuate themſelves into the ſolid body, and looſen its parts.

Mr. *Thomas Molyneux* obſerves as to this ſolution, that tho' the union of liquors be eaſily deſtroyed, yet ſome degree of force is requiſite to effect it; however, he thinks, this property ought not to be relied on, as the ſole cauſe of this appearance; for, in this ſolution of the problem, we firſt ſuppoſe the minute particles of a heavy body raiſed, and then aſſign the reaſon of their not ſinking; whereas it is not to be queſtioned, but that the force which raiſed them is the ſame that ſuſtains them.

The heights of the Mercurial Cylinder at any elevation above the Surface of the Earth; *and the riſing and falling of the Mercury on the change of* Weather; *by Mr.* Halley. Phil. Tranſ. N° 181. p. 104.

THE elaſticity of the air has been long ſince made out by experiments before the Royal Society and elſewhere; and the reſiſtance of its ſpring is found to be nearly equal to the weight or force that compreſſes it; as alſo that the ſpaces, the ſame air occupies under different preſſures, are reciprocally as thoſe preſſures; it has been likewiſe ſhewn by undoubted experiment, that the ſpecific gravity of the air near the earth's ſurface, to that of water, was, at one time, as 1 to 840; at a ſecond trial as 1 to 852; at a third trial, in a very large veſſel holding ten gallons, as 1 to 860; all which, conſidering the difficulty of the experiment, agree well enough together, the mercury ſtanding at all thoſe times, at about 29 $\frac{3}{4}$ inches; but becauſe it was ſummer-weather, and conſequently the air was rarified, when theſe experiments were made, we may, without a ſenſible error, ſay in round numbers, that the barometer ſtanding at 30 inches, and in a mean ſtate of heat and cold, the ſpecific gravity of the air to water, is as 1 to 800; by the like experiments the weight of mercury to water is as 13 $\frac{1}{2}$ to 1, or nearly ſo; ſo that the weight of mercury to air, is as 10800 to 1; and a cylinder of air of 10800 inches or 900 feet is equal to an inch of mercury; and were the air of an equal denſity like water, the whole atmoſphere would be no more than 5, 1, miles high, and in the aſcent of every 900 feet, the barometer would ſink an inch; but the expanſion of the air, encreaſing in the ſame proportion as the incumbent weight of the atmoſphere decreaſes, that is, as the mercury in the barometer ſinks, the upper parts of the air are much more rarified than the lower, and each ſpace, anſwering to an inch of quickſilver, grows ſtill larger; ſo that the atmoſphere muſt be extended to a much greater height: Now upon theſe principles, to determine the height of the mercury at any aſſigned height of the air, and *e-contra*, having the height of the mercury given, to find the height of the place, where the barometer ſtands, are problems not more difficult than curious; and which are thus reſolved.

The expanſions of the air being reciprocally as the heights of the mercury, it is evident, that by means of the hyperbola, and its aſſymptotes, the ſaid expanſions may be expounded to any given height of the mercury; for by the 65th *Prop. Lib.* 2. *Conic Mydorgii*, the rectangles ABCE, AKGE, ALDE, *&c.* Fig. 3. Plate XI. are always equal, and conſequently the ſides CB, GK, LD, *&c.* are reciprocally as the ſides AB, AK, AL, *&c.* if then the lines AB, AK, AL be ſuppoſed equal to the heights of the mercury, or the preſſures of the atmoſphere, the lines CB, KG, LD, anſwering thereto, will be as the expanſions of the air under thoſe preſſures, or the ſpaces that the ſame quantity of air will occupy; which expanſions being taken infinitely many, and infinitely ſmall, according to the method of indiviſibles, their ſum will give the ſpaces of air between the ſeveral heights of the barometer; that is, the ſum of all the lines between CB and KG, or the area CBKG will be proportional to the diſtance or ſpace intercepted between the level of two places in the air, where the mercury would ſtand at the heights repreſented by the lines AB, AK; ſo then the ſpaces of air, anſwering to equal parts of mercury in the barometer, are as the areas CBKG, GKLD, DLFM, *&c.* Theſe areas again are by the demonſtration of *Gregory* of St. *Vincent*, proportional to the logarithms of the numbers expreſſing the ratio's of AK to AB, of AL to AK, of AM to AL, *&c.* ſo then by the common table of logarithms, the height of any place in the atmoſphere, having any aſſigned height of the mercury, may moſt eaſily be found; for the line CB in the hyperbola, whoſe areas deſign the tabular logarithms, being, 0,0144765, it will be, as 0,0144765, to the difference of the logarithms of 30, and any other leſſer number, ſo 900 feet, or the ſpace anſwering to an inch of mercury, if the air were equally preſſed with 30 inches of mercury, and every where alike, to the height of the barometer in the air, where it will ſtand at that leſſer number of inches: And by the converſe of this proportion, the height of the mercury may be found, having the altitude of the place given.

Upon theſe ſuppoſitions it appears, that at the height of 41 miles, the air is ſo rarified, as to take up 3000 times the ſpace it occupies here, and at 53 miles high, it would be expanded above 30000 times; but it is probable, the utmoſt power of its ſpring cannot exert itſelf to ſo great an extenſion, and that no part of the atmoſphere reaches above 45 miles from the ſurface of the earth.

This ſeems confirmed from the obſervations of the *Crepuſculum*, which is obſerved commonly to begin and end, when the ſun is about 18° below the horizon; for ſuppoſing the air to reflect light from its moſt rarified parts, and that as long as the ſun illuminates any of its atoms, they are viſible to an eye not hindred by the curvity of the earth; it will follow from Fig. 4. that the proportion of the height of the whole air, to the ſemidiameter of the earth, is much about, as 1 to 90, or as the exceſs of the ſecant of about 8½ deg. to the radius; for if E be the eye of the obſerver, S a place where the ſun ſets at the end of twilight in E, and the arch ECS, or TCA be found 18°, the exceſs of the ſecant of half thereof ECH, would be the height of the air, *viz.* GH; but the ſun's ray ASH, and the viſual ray EH, do each of them ſuffer a refraction of about 32 or 33 min. whereby being bent inwards from H towards G, the height of the air need not be ſo great, as if they proceeded ſtraight on; and having from the angle ECS taken the double refraction of the horizontal ray, the half of the remainder will be about 8½ deg. whoſe ſecant being 111, it follows that as 10000 to 111, ſo the ſemi-diameter of the earth, ſuppoſed 4000 miles, to 44, 4 miles, which will be the height of the whole air, if the places E, S, whoſe viſible portions of the atmoſphere ERZH, and SHKB juſt touch each other, be 18° aſunder: At this height the air is expanded into above 3000 times the ſpace it poſſeſſes below; and it hath been condenſed into the 60th part of the ſame ſpace, ſo that it ſhould ſeem, that the air is a ſubſtance capable of being compreſſed into the 180000th part of the ſpace, it would naturally take up, when free from preſſure; now what texture or compoſition of parts ſhall be capable of this great expanſion and contraction, ſeems a very hard queſtion; and which is ſcarce ſufficiently accounted for, by the comparing it to wool, cotton, and the like ſpringy bodies.

Hitherto the air and atmoſphere have been conſidered as one unaltered body, as having conſtantly at the earth's ſurface the 800th part of the weight of water, and being capable of rarefaction and condenſation *in infinitum*, neither of which is true; for the weight of the whole atmoſphere is various, being counterpoiſed ſometimes by 28 ½ inches of mercury, and at other times by no leſs than 30 ½; beſides heat and cold do conſiderably dilate and contract the air, and conſequently alter its gravity, to which add the mixture of effluvia, or ſteams ariſing from almoſt all bodies, which, aſſimilating into the form of air, are kept ſuſpended therein, as ſalts diſſolved in liquors, or metals in corroding menſtruums; which bodies being much heavier than air, their particles, by their admixture, muſt needs encreaſe the weight of that air, with which they lie incorporated, after the ſame manner as melted ſalts do augment the ſpecific gravity of water: The other conſideration is, that the rarefaction and condenſation of the air is not preciſely according to the proportion here laid down; for theſe condenſations are poſſible, only beyond certain degrees; for air being compreſſed into an 800th part of its ſpace, it would be equally denſe with water, which latter yields not to any force whatever, as hath been ſhewn by ſeveral experiments; neither can the rarefaction proceed *in infinitum*; for ſuppoſing the ſpring, whereby it dilates itſelf, to ariſe from any texture of parts you pleaſe, yet there muſt be a determinate magnitude of the natural ſtate of each particle, which they cannot exceed: Tho' theſe objections affect the accuracy of theſe concluſions, drawn from the ſpecific gravity of the air, obſerved at any time, yet the method, here ſhewn, will by a like calculation, give the heights of the quickſilver, and the rarefaction of the air from any aſſigned height of the barometer at the earth's ſurface, and any ſpecific gravity given: As to the condenſation and rarefaction by heat and cold, and the various mixture of aqueous and other vapours, theſe two objections ſeem generally to compenſate each other; for when the air is rarified by heat, the vapours are raiſed moſt copiouſly; ſo that tho' the air, properly ſo called, be expanded, and conſequently lighter, yet the interſtices thereof being crouded full of vapours, which are much heavier bulk for bulk, the weight of the whole muſt continue much the ſame.

It may not here be improper to account for the difference of the height of the mercury at one time from what it is at another; firſt, then it is demonſtrable that the height of the cylinder of mercury is equal to the weight of the whole incumbent air; and conſequently, that difference of the height of the mercury muſt be owing either to a diminution or an addition of new matter to the air: The principal cauſe of the riſe and fall of the mercury are the variable winds, which are found in the temperate zones; a ſecond cauſe is the uncertain riſing and falling of the vapours lodged in the air, whereby it becomes at one time much more crouded than at another, and conſequently heavier; but this latter in a great meaſure depends upon the former: Now from theſe principles, the ſeveral phænomena of the barometer may be explained; as firſt, why in calm weather, the air being inclined to rain, the mercury is commonly low; the anſwer is, that the mercury being low, inclines it to rain; for the air being light, the vapours are no longer ſupported thereby, becoming ſpecifically heavier; ſo that they deſcend towards the earth, and in their fall, meeting with other aqueous particles, they incorporate together, and form little drops of rain; but the mercury being at one time lower than at another, is the effect of two contrary winds, blowing from the place where the barometer ſtands; whereby the air of that place is carried both ways from it, and conſequently the incumbent cylinder of air is attenuated, and accordingly the mercury ſinks; for inſtance, if it ſhould blow in the *German* ocean a weſterly wind, and at the ſame time an eaſterly in the *Iriſh* ſea; or, if in *France* it ſhould blow a ſoutherly wind, and in *Scotland* a northerly; it muſt be granted, that that part of the atmoſphere over *England* would thereby be rarified, and the mercury ſubſide; and conſequently the vapours, which before floated in thoſe parts of the air, of equal gravity with themſelves, would ſink to the earth. 2. Why in ſerene ſettled weather, the mercury is generally high; this greater height of the barometer is cauſed by two contrary winds blowing towards the place of obſervation, whereby the air of other places is brought thither and accumulated; ſo that the incumbent cylinder of air being encreaſed both in height and weight, the mercury muſt neceſſarily riſe; and then the air being ſpecifically heavier, the vapours are better kept ſuſpended. 3. Why upon very great winds or ſtorms, tho' accompanied with no rain, the mercury ſinks loweſt of all, with relation to the point of the compaſs, on which the wind blows: This is cauſed by the very rapid motion of the air in theſe ſtorms; for the tract of the earth's ſurface, wherein theſe winds rage, not extending all around the globe, that ſtagnant air, which is left behind, as alſo that on the ſides, cannot come in ſo faſt as to ſupply the evacuation made by ſo ſwift a current, ſo that the air muſt neceſſarily be attenuated, more or leſs according to the violence of theſe winds; to which add, that the horizontal motion of the air, being ſo quick as it is, may in all probability take off ſome part of its perpendicular preſſure; and the great agitation of its particles is the reaſon, why the vapours are diſſipated, and do not condenſe into drops, ſo as to form rain, which otherwiſe is the natural conſequence of the rarefaction of the air. 4. Why, all other things being equal, the mercury ſtands higheſt, on an eaſterly, or north-eaſterly wind: This happens, becauſe that in the great *Atlantic* ocean on this ſide the 35th degree of N. Lat. the weſterly and ſouth-weſterly winds blow almoſt always trade, ſo that whenever the wind comes up here at eaſt and north-eaſt, it is ſure to be checked by a contrary gale, as ſoon as it reaches the ocean; on which account the air muſt needs be heaped over this iſland, and conſequently the mercury ſtand high, as often as theſe winds blow: This holds true in this country, but is not a general rule for other places, where the winds are under different circumſtances. 5. Why in calm froſty weather, the mercury generally ſtands high: The cauſe of this is, that it ſeldom freezes, but when the winds are northerly and north-eaſterly; or at leaſt, unleſs thoſe winds blow at no great diſtance off; for the northern parts of *Germany*, *Denmark*, *Sweden*, *Norway*, and all that tract from whence north-eaſterly winds blow, are ſubject to almoſt continual froſt all the winter; and thereby the lower air is very much condenſed, and in that ſtate it is brought hither, and being accumulated by the oppoſition of the weſterly wind, blowing in the ocean, the mercury muſt needs be preſſed to a more than ordinary height. 6. Why after very great ſtorms of wind, when the mercury has been very low, it generally riſes again very faſt. This ſeems to be cauſed by the ſudden acceſſion of new air to ſupply the great evacuation, which ſuch continued ſtorms make thereof; and by the recoil of the air, after the ceaſing of the force that impelled it; and the reaſon, why the mercury riſes ſo faſt, is becauſe the air being very much rarified beyond its mean denſity, the neighbouring air runs in, the more ſwiftly to bring it to an equilibrium. 7. Why in more northerly places, the variations of the barometer are greater than in the more ſoutherly; the truth of the matter of fact is proved from obſervations made at *Stockholm*, compared with others at *Clermont* and *Paris*; the reaſon of which ſeems to be, that the more northerly parts have uſually greater ſtorms of wind than the more ſoutherly, whereby the mercury ſhould ſink lower in that extreme; and then the northerly winds bringing the condenſed and ponderous air from the neighbourhood of the *Pole*, and that again being checked by a ſoutherly wind at no great diſtance, and being thus accumulated, muſt of neceſſity make the mercury in ſuch caſe ſtand higher in the other extreme. 8. And laſtly, why near the equinoctial, as at *Barbadoes* and St. *Helena*, there is very little or no variation of the height of the barometer: This remark, above all others, confirms the hypotheſis of the variable winds being the cauſe of theſe variations of the height of the mercury; for in the places above-mentioned, there is always an eaſy gale of wind blowing nearly upon the ſame point, *viz.* E. N. E. at *Barbadoes*, and E. S. E. at St. *Helena*; ſo that there being no contrary currents of the air to exhauſt, or accumulate it, the atmoſphere continues much in the ſame ſtate: However, upon hurricanes, the moſt violent of ſtorms, the mercury has been obſerved very low, but this is but once in two or three years, and it ſoon recovers its ſettled ſtate, *viz.* about 29 ½ inches.

The principal objection againſt this doctrine is, that it ſuppoſes the air ſometimes to move from thoſe parts, where it is already evacuated below the equilibrium, and ſometimes again towards thoſe parts, where it is condenſed, and crouded above the mean ſtate; which may be thought contradictory to the laws of ſtatics, and the rules of the equilibrium of fluids; but if we conſider, that when once an impetus is given to a fluid body, it is capable of mounting above its level, and checking others, that have a contrary tendency to deſcend by their own gravity, this will be no material objection; but we ſhall rather conclude, that the great analogy between the riſing and falling of the water on the flux and reflux of the ſea, and this of the accumulating and exhauſting of the air, is a great argument for the truth of this hypotheſis; for as the ſea, overagainſt the coaſt of *Eſſex*, riſes and ſwells by the meeting of the two contrary tides of flood, of which one comes from the S. W. along the *Engliſh* channel, and the other from the north; and on the contrary, ſinks below its level on the retreat of the water both ways, in the tide of ebb; ſo it is very probable, that the air may ebb and flow after the ſame manner; but by reaſon of the diverſity of cauſes, whereby the air may be put into motion, the times of theſe fluxes and refluxes are purely caſual, and not reducible to any rule, as are the motions of the ſea, depending wholly on the regular courſe of the moon.

An Eſſay towards an Univerſal Alphabet; *by Mr.* Lodwick. Phil. Tranſ. N° 182. p. 126.

UPON obſerving a great difficulty in truly writing what is pronounced, or truly pronouncing what is written, either in our own, or foreign languages, by the common alphabets now in uſe; ariſing either from the want of ſome letters, or the different pronounciation of the ſame character, or letter, in different languages, and the irregularities of its various ſounds in any one language; Mr. *Lodwick* ſaw a neceſſity of ſome ſuch expedient, as is here attempted, *viz.* an univerſal alphabet, which ſhould contain an enumeration of all ſuch ſingle ſounds, or letters, as are uſed in any language: By this means, 1. Children, being at firſt taught and accuſtomed to the true expreſſion of all theſe ſingle ſounds or letters, will, without difficulty, be brought to pronounce truly and readily any language; for the difficulty ſome perſons have to pronounce ſome letters, is owing to their not being accuſtomed to pronounce them, either ſingle or in conjunction with others; which is the caſe chiefly as to perſons come to age. 2. Any one, accuſtomed to the true pronounciation of this alphabet, will be enabled to deſcribe the pronounciation of any language whatever, and, altho' he had never before heard this language pronounced, be able truly to ſound it. 3. This alphabet will alſo be uſeful to perpetuate the true ſounds of any language, and ſerve as a ſtandard thereof to ſucceeding ages; for, if all the ſingle ſounds be here characterized, and that no one character have more than one ſound, nor any one ſound be expreſſed by more than one character, it cannot happen that any character ſhould be falſely pronounced, but it will ſoon be diſcovered; for this falſe ſound muſt be the true ſound of ſome other letter of this alphabet: In this collection, the following rules are obſerved. 1. That no true ſingle ſound can be juſtly deſcribed or expreſſed by the conjunction of any two more or ſingle ſounds; *viz.* if a vowel, by the conjunction of other ſingle vowels; or if a conſonant, by the conjunction of other ſingle conſonants. 2. That whatever ſound cannot be expreſſed or deſcribed, but by the conjunction of two or more ſingle ſounds, is no ſingle but a compounded ſound. 3. That in every compoſition of ſingle ſounds, the particular ſingle ſounds, which make up that compoſition, ought to be truly and clearly diſcerned in the ſound of the compoſition, otherwiſe it cannot be truly ſaid to be a compoſition, and formed of ſuch ſingle ſounds.

The ſingle ſounds, commonly called letters, are diſtinguiſhed uſually into vowels and conſonants; vowels are ſuch as are ſingly expreſſible, as *a*, *e*, *i*, *o*, *&c.* Conſonants are ſuch as cannot ſingly be expreſſed without the conjunction of a vowel, as *b*, *d*, *f*, *g*, *&c.* The whole number of vowels are theſe 14 following; to which, for the better diſtinguiſhing their ſounds, are annexed ſo many words, wherein they are expreſſed, all *Engliſh*, except three, *viz.* 7, 8, 12, becauſe no *Engliſh* words occured wherein they are expreſſed.

1. *a*, as tall.
2. *a*, tallow.
3. *a*, tale.
4. *e*, tell.
5. *ea*, teal.
6. *i*, till.
7. *u*, dure, *French.*
8. *ui*, muis, *Low Dutch.*
9. *i*, tile.
10. *o*, tone.
11. *u*, tunne.
12. *u*, une, *French.*
13. *oo*, tool.
14. *ou*, could.

Theſe are the vowels, each of which are long and ſhort; ſhort as in the words God, man, ſin; long, as in ball, demand, ſeen, *&c.*

A diphthong in the ordinary uſe of the word, ſignifies a compound of two vowels; but thoſe, commonly ſo called, are moſt of them nothing but ſingle vowels, as *ea*, *oo*, *ou*, *eo*, *ai*, in the words, *teal*, *tool*, *could*, *people*, *main*, &c. that theſe are but ſingle ſounds will appear, if we conſider the ſounds of the vowels ſingly, which make thoſe ſuppoſed compoſitions; and then whether thoſe ſounds in compoſition will make out the true ſound required, ſo as both of them may be clearly diſcerned in theſe pretended compounds; for inſtance, *ea* in *teal*, conſider the ſound of *e* in the words *ſent* or *ſcene*; and *a* in the words *ball*, *and*, or *tale*; and then whether *e*, in either of the two ſounds going before, and *a* in either of the three ſounds following, joined together, will make out the true ſound of *ea* in the word *teal*; if not, then it is a ſingle ſound: Thus, if you proceed to examine all the others, you will find the ſame thing, and that the true diphthongs and triphthongs of the *Greeks* to be no other but a true expreſſion of the ſingle vowels, they joined together, but in ſo ſhort a time, as that both or all three were expreſſed in the time, that ordinarily one ſingle vowel was expreſſed.

Digitize

The whole number of conſonants are ranged in the following table into 10 files and 6 ranks; *Fr.* ſignifies *French*; *L. D.* *Low Dutch*; *W. Welſh.*

	1	2	3		4		5
1	*b.* bond	*d.* dark	*j.* jeſt		*g.* game		=
2	*p.* pond	*t.* tart	*ch.* cheſt		*k.* came		=
3	*m.* mind	*n.* name	*gn.* ſeignior	*Fr*	*ng.* ſong		=
4	=	*dh.* this	*j.* jean		*g.* gaen	*L.D.*	*v.* valley
5	=	*th.* thing	*ſh.* ſhall		*ch.* dach		*f.* folly
6		*n.* danſe, *Fr.*					

	6	7	8	9	10	11
1	=	*l.* lane	*h.* hand	*y.* yarn	*r.* rand	*w.* wand
2	=					
3	=					
4	*z.* zeal	*lh.* *w.*				
5	*ſ.* ſeal					
6						

The firſt file contains 3 conſonants; the ſecond 6; the third and fourth 10; the fifth and ſixth 4; the ſeventh 2; the remaining four, each 1, in all 29 conſonants: The ſecond rank in each file contains derivatives, in relation to the firſt rank, or their primitives, all alike in kind; ſo alſo all the derivatives are in the third, fourth, and fifth ranks, whereby their ſounds will be the better comprehended: Thoſe places filled by two ſtrokes (=) ſignify that ſounds may be expreſſed by the ſame poſition of the parts of the mouth with that of their primitives, anſwering in kind to thoſe in the ſame rank, wherein they ſtand; but they would be ſo alike in pronounciation to ſome others in the table, that the difference would be too nice for common diſcernment: As thoſe of the fourth and fifth ranks in the firſt file, are like thoſe of the fourth and fifth ranks in the fifth file; and thoſe of the firſt, ſecond, and third ranks in the fifth file are like thoſe of the ſame ranks in the firſt file, ſo thoſe, of the firſt, ſecond, and third ranks in the 6th file, are like thoſe of the ſame ranks in the ſecond file: Some of theſe above-mentioned conſonants are vulgarly ſuppoſed compounded, as *th*, *ch*, *ſh*, *gn*, *ng*, &c. but if we conſider the ſound of each ſingle conſonant in the compoſition a-part, and then the conjunction of them in that order, ſo as the ſingle ſounds may be clearly diſcerned in the compoſition, you will never form the ſounds required; and if neither by this, or any other conjunction, the required ſound can be made out, it muſt be a ſingle, and no compound ſound: All ſingle ſounds ſhould have ſingle and diſtinct characters; but it will be impoſſible in the uſe of the preſent characters or alphabets, to add thoſe that are wanting, and correct and limit the ſound of others in uſe, thereby to conſtitute a perfect alphabet; becauſe people ſo long accuſtomed or habituated to the corrupt and different pronounciations of the preſent characters, will be always ſubject, on the ſight of the old, to give them thoſe ſounds they have been uſed to, and to ſpell words according to their old and corrupt cuſtom, whatſoever rules ſhall be preſcribed to the contrary. In the following table, Fig. 4. Plate XI. there is therefore given a new ſet of literal characters, both conſonantal and vocal; the ſet of conſonants is ranged in the ſame method and order with thoſe in the preceeding table; the firſt rank in every file, are thoſe called radical characters; the other ſucceeding ranks have each a diſtinct characteriſtical addition to diſtinguiſh them from each other, which cauſes ſome complication; but yet it was judged neceſſary to expreſs the ſame in the character, the more regular to ſort them into claſſes, and to expreſs the derivation of letters of the ſame organ, the one from the other; the ſet of vocal characters are likewiſe in the ſame table: In writing they are to be placed over the conſonants, which they follow in expreſſion; and whereas ſome ſyllables begin with a vowel, place the twelfth conſonantal character, anſwering to the *Hebrew Aleph*; and over the ſame, place the vowel beginning ſuch a ſyllable: To diſtinguiſh the long vowels from the ſhort, add a prick to the vocal character: The 9, 11, 12, 13, 14th vocal characters are, for want of ſingle ſtrokes, compounded of the firſt and ſecond: The diphthongs, truly ſuch, may be made by the conjunction of the ſingle vocal characters as they follow in order, and they will be eaſily diſtinguiſhed from the five preceeding compounded characters of the ſingle vowels, becauſe there will not probably occur any diphthong, compounded of the firſt two vowels: The accent may be a croſs line under the ſyllable that is to be accented; the characters, ſignifying the various modes of expreſſion, may be the following, and ought to be placed at the beginning and end of every ſentence, as it is neceſſary; [ ] explication, ( ) parentheſis, ¡ ¡ emphaſis, ? ? interrogation, ! ! wonder, ¿ ¿ irony.

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An Eſſay towards an Univerſal Primer; *by Mr.* Lodwick.

Phil. Tranſ. N° 182. p. 134.

AS the preſent alphabets are imperfect, ſo are alſo the primers, or firſt books, wherein children and others are taught to ſpell and read; firſt, in not having a perfect alphabet; ſecondly, in not being digeſted in ſuch a method, as is fit and proper to teach them, as they ought to be taught; for the uſual way of teaching to ſpell is to diſmember every ſyllable, of more than one letter, into many ſyllables, by expreſſing every letter apart, and ſyllabically, and the conſonants with ſuch a vowel as they are ordinarily named with, and then requiring them to join theſe ſyllables into one word; but how prepoſterous this method is, one inſtance will ſhew: Suppoſe the monoſyllable *brand* be to be ſpelled, they will teach them thus to diſmember it, *bee*, *er*, *a*, *en*, *dee*, and then require them to join theſe into one ſyllable, which it is impoſſible to do, and they muſt be neceſſitated, as they have begun, to expreſs this one ſyllable by five ſyllables, which was not deſigned; whereas they ſhould teach them to expreſs every ſyllable entire at firſt ſight, without diſmembring it; and to do this they muſt proceed gradually; firſt, beginning with the moſt ſimple ſyllables, and ſo by degrees proceeding to the more difficult and compounded, till they can readily pronounce a whole ſyllable at firſt ſight, even the moſt difficult; to that end, let all the primers be thus contrived; at the top of the leaf, let all the vowels be placed ſingly in order as they follow in one rank; and under the ſame, place ſyllables; firſt, of one vowel and one conſonant following it, throughout all the variations; then of one conſonant and one vowel following; ſecondly, of two conſonants before, and one vowel following, throughout the variations; thirdly, of one vowel and three or four conſonants following, and of three conſonants going before, and one vowel following; fourthly, of one, two or three conſonants going before a vowel, and one, two, three or four conſonants following; fifthly, ſome ſyllables with diphthongs or triphthongs; for inſtance

a	*e*	*i*	*o*	*u*
ab	*eb*	*ib*	*ob*	*ub*
ad	*ed*	*id*	*od*	*ud*
ba	*be*	*bi*	*bo*	*bu*
ald	*eld*	*ild*	*old*	*uld*
dra	*dre*	*dri*	*dro*	*dru*
balm	*belm*	*bilm*	*bolm*	*bulm*, &c. &c.

After this, place a number of words of two, three, or four ſyllables, from the eaſieſt to the moſt difficult expreſſions, without regarding their ſignifications; further let there follow ſome words of ſeveral ſyllables, with the accent variouſly placed, as on the firſt, ſecond, third, *&c.* ſyllable, let there be alſo two or three ſmall diſcourſes writ in this alphabet, in ſo many different languages, with the accents rightly placed, and truly diſtinguiſhed by their pauſes; and thus you have a perfect primer: In teaching by this primer, begin with the true ſound of all the vowels ſingly, then proceed to the following ſingle ſyllables, beginning with the eaſieſt of expreſſion, and ſo on, gradually to the moſt difficult, and then to words of more ſyllables; and laſtly, to the uſe of the accent and pauſes; when the learner hath paſſed all theſe, you may exerciſe him in the reading of the diſcourſes, and let him exactly obſerve the accent and the pauſes; when they can read and utter exactly whatſoever is written in this character, in what language ſoever, teach them to write truly, what they hear diſtinctly expreſſed, according to this alphabet, proceeding therein gradually as before; and obſerving rightly to place the accent and pauſes, and alſo to know the uſe of the ſigns of the different modes of ſpeaking.

In teaching obſerve theſe neceſſary rules: 1. Proceed leiſurely and orderly; ſuffer not a miſpronounciation to paſs uncorrected: 2. In ſpelling let no ſyllable be diſmembred by repeating the letters ſingly, but let them be pronounced whole, as they are found: This new primer will without alteration, except of the title, be the ſame for all nations and languages.

An Hiſtorical Account of the Trade-Winds *and* Monſoons, *obſervable in the Seas between and near the* Tropics, *with an attempt towards their phyſical Cauſe; by Mr.* Edm. Halley. Phil. Tranſ. N° 183. p. 153.

THE whole ocean may moſt properly be divided into three parts; *viz.* 1. The *Atlantic* and *Ethiopic Sea.* 2. The *Indian Ocean.* 3. The great *South Sea*, or the *Pacific Ocean:* In the *Atlantic* and *Ethiopic Seas* between the *Tropics*, there is a general eaſterly wind, all the year long, without any conſiderable variation, excepting that it is ſubject to be deflected therefrom, ſome few points of the compaſs towards the north or ſouth, according to the poſition of the place; and on theſe deflections the following obſervations have been made; *viz.* 1. that near the coaſt of *Africa*, as ſoon as you have paſſed the *Canary* iſlands you are ſure to meet a freſh gale of wind at N. E. about the latitude of 28° north, which ſeldom comes to the eaſtward of the E. N. E. or paſſes the N. N. E: This wind accompanies thoſe bound to the ſouthward, to the latitude of 10° N. and about 100 leagues from the *Guinea* coaſt, where to the 4° of N. Lat. they fall into calms and tornados: 2. That thoſe bound to the *Caribbe* iſlands, find as they approach the *American* ſide, that the abovementioned N. E. wind becomes ſtill more and more eaſterly, ſo as ſometimes to be eaſt, ſometimes E. by S. but yet moſt commonly a point or two to the northward of the eaſt, and ſeldom more; it is likewiſe obſerved, that the ſtrength of theſe winds does gradually decreaſe, as you ſail to the weſtward. 3. That the limits of the trade and variable winds in this ocean, are farther extended on the *American* ſide than on the *African*; for whereas you meet not with this certain wind, till after you have paſſed the latitude of 28° on this ſide; on the *American* ſide it commonly holds to 30, 31, or 32° of latitude; and this is likewiſe verified to the ſouthwards of the *Equinoctial*; for near the *Cape* of *Good Hope*, the limits of the trade winds are 3 or 4° nearer the *Equinoctial* than on the coaſt of *Braſil*: 4. That from the latitude of 4° N. to the aforeſaid limits on the ſouth ſide of the *Equator*, the winds are generally and perpetually between the ſouth and eaſt, and moſt commonly between the ſouth-eaſt and eaſt; obſerving always this rule, that on the *African* ſide they are more ſoutherly, on the *Braſilian* more eaſterly, ſo as to become almoſt due eaſt, the little deflection they have being ſtill to the ſouthward: In this part of the ocean Mr. *Halley* found the winds conſtantly about the ſouth-eaſt, the moſt uſual point S. E. *b*. E. when it was eaſterly it generally blew hard, and was gloomy, dark and ſometimes rainy weather; if it came to the ſouthward it was generally ſerene, and a gentle gale next to a calm, but this not very common; he never obſerved it to the weſtward of the ſouth, or northward of the eaſt. 5. That the ſeaſon of the year hath ſome ſmall influence on theſe trade-winds; for when the ſun is conſiderably to the northward of the *Equator*, the ſouth-eaſt winds, eſpecially in the ſtreight of this ocean between *Braſil* and the coaſt of *Guinea*, do vary a point or two to the ſouthward, and the north-eaſt become more eaſterly; and on the contrary, when the ſun is towards the *Tropic* of *Capricorn*, the ſouth-eaſterly winds become more eaſterly, and the north-eaſterly winds on this ſide the *Equator* veer more to the northward.

ward. 6. That as there is no general rule but admits of ſome exception, ſo there is in this ocean, a tract of ſea, wherein the ſoutherly and S. W. winds are perpetual; *viz.* all along the coaſt of *Guinea*, for above 500 leagues together, from *Sierra Leona* to the iſle of St. *Thomas*; for the ſouth-eaſt trade-wind, having paſſed the *Line*, and approaching the coaſt of *Guinea* within 80 or 100 leagues inclines towards the ſhore, and becomes S. S. E. and by degrees, as you come nearer, it veers about to S. S. S. W. and in with the land ſouth-weſt, and ſometimes weſt ſouth-weſt: Theſe are the winds, which are obſerved on this coaſt, when it blows true, but there are frequent calms, violent ſudden guſts, called *Tornados*, from all points of the compaſs, and ſometimes unwholeſome foggy eaſterly winds, called *Hermitaa* by the natives, which too often infeſt the navigation of theſe parts. 7. That to the northward of the *Equator*, between 4 and 10 degrees of latitude, and between the meridians of *Cape Verde*, and of the eaſt or moſt iſlands that bear that name, there is a tract of ſea, wherein it were improper to ſay, there is any trade-wind, or yet a variable one, for it ſeems condemned to perpetual calms, attended with terrible thundering and lightning, and rains ſo frequent, that this part of the ſea is called the *Rains:* The little winds that are, are only ſome ſudden uncertain guſts, of very ſhort continuance and leſs extent; ſo that ſometimes each hour there is a different gale, which dies away into a calm before another ſucceeds; and in a fleet of ſhips, in ſight of each other, each ſhall have the wind from a ſeveral point of the compaſs: With theſe weak breezes ſhips are obliged to make the beſt of their way to the ſouthward thro' the aforeſaid ſix degrees, wherein, it is reported, ſome have been detained whole months for want of wind.

From the three laſt obſervations is ſhewn the reaſon of two notable phænomena in the *Eaſt-India* and *Guinea* navigations; the one is, why notwithſtanding the narroweſt part of the ſea between *Guinea* and *Braſil* be about 500 leagues over, yet ſhips bound to the ſouthward, eſpecially in the months of *July* and *Auguſt*, find a great difficulty to paſs it; this happens, becauſe of the ſouth-eaſt winds, at that time of the year commonly extending ſome degrees beyond the ordinary limits of 4° N. Lat. and withal, coming ſo much ſoutherly, as to be ſometimes ſouth, ſometimes a point or two to the weſt; it then only remains to ply to wind-ward; and if, on the one ſide, they ſtand away W. S. W. they gain the wind ſtill more and more eaſterly, but there is danger of not weathering the *Braſilian* ſhore, or at leaſt the ſhoals on that coaſt; but if, on the other tack, they go away E. S. E. they fall into the neighbourhood of the coaſt of *Guinea*, from which there is no departing, without running eaſterly, as far as the iſland of St. *Thomas*, which is the conſtant practice of all the *Guinea* ſhips, and which may ſeem very ſtrange without conſidering the ſixth remark; for being in with the coaſt, the wind blows generally at S. W. and W. S. W. with which winds they cannot go to the northward for the land, and on the other tack they can lie no nearer the wind than S. S. E. or ſouth; with theſe courſes they run off the ſhore, but in ſo doing they always find the winds more and more contrary; ſo that when near the ſhore they can lie ſouth; at a greater diſtance they can make no better than S. E. and afterwards E. S. E. with which courſes they commonly fetch the iſle of St. *Thomas* and *Cape Lopez*, where finding the winds to the eaſtward of the ſouth, they have them favourable by running away to the weſtward in the S. Lat. of three or four degrees, where the ſouth-eaſt winds are perpetual: On account of theſe general winds, all thoſe that uſe the *Weſt-India* trade, even thoſe bound to *Virginia*, reckon it their beſt courſe to get as ſoon as they can to the ſouthwards, that ſo thay may be certain of a fair and freſh gale to run before it to the weſtward; and for the ſame reaſon thoſe homewards bound from *America* endeavour to gain the latitude of 30 degrees, as ſoon as poſſible, where they firſt find the winds began to be variable; tho' the moſt ordinary winds in the northern part of the *Atlantic* ocean come from between the ſouth and weſt.

What is here ſaid is to be underſtood of the ſea-winds, at ſome diſtance from the land; for upon and near the ſhore, the land and ſea-breezes are almoſt every where ſenſible; and the great variety, which happens in their periods, force, and direction, ariſes from the ſituation of the mountains, vallies and woods, and from the various texture of the ſoil, more or leſs capable of retaining and reflecting heat, and of exhaling or condenſing vapours.

In the *Indian* ocean, the winds are partly general, as in the *Ethiopic* ocean partly periodical; that is, half the year they blow one way, and the other half, nearly upon the oppoſite points; and theſe points and times of ſhifting are different in different parts of the ocean; the limits of each tract of ſea, ſubject to the ſame change or *Monſoon*, are certainly very hard to determine, yet the following particulars, the reſult of great diligence and application, may be relied on. 1. That between the latitudes of 10 degrees and 30 ſouth, as between *Madagaſcar* and *Hollandia Nova*, the general trade-wind about the S. E. *b.* E. is found to blow all the year long, in the ſame manner, as in the ſame latitudes in the *Ethiopic* ocean. 2. That the aforeſaid S. E. winds extend to within two degrees of the *Equator*, during the months of *June*, *July*, *Auguſt*, *&c.* to *November*, at which time between the S. Lat. of 3 and 10 degrees, being near the meridian of the north end of *Madagaſcar*, and between two and twelve ſouth latitude, being near *Sumatra* and *Java*, the contrary winds from the N. W. or between the north and weſt, ſet in and blow for half the year; *viz.* from the beginning of *December* to *May*; and this *Monſoon* is obſerved as far as the *Molucca* iſles. 3. That to the northward of 3 degrees S. Lat. over the whole *Arabian* or *Indian Sea*, and gulf of *Bengal*, from *Sumatra* to the coaſt of *Africa*, there is another *Monſoon*, blowing from *October* to *April*, upon the N. E. points; but in the other half year, from *April* to *October*, upon the oppoſite points of S. W. and W. S. W. and with more force than the other, accompanied with dark, rainy weather; whereas the N. E. blows clear; it is likewiſe to be noted, that the winds are not ſo conſtant, either as to their ſtrength, or the point from whence they blow, in the gulf of *Bengal*, as they are in the *Indian Sea*, where a certain ſteady gale ſcarce ever fails: It it alſo remarkable, that the S W. winds in theſe ſeas are generally more ſoutherly on the *African* ſide, and more weſterly on the *Indian*. 4. There is a tract of ſea to the ſouthward of the *Equator*, ſubject to the ſame changes of the winds; *viz.* near the *African* coaſt, between it and the iſland *Madagaſcar*, and from thence northwards, as far as the *Line*; wherein from *April* to *October* there is found a conſtant freſh S. S. W. wind, which, as you go more northerly, becomes ſtill more and more weſterly, ſo as to fall in with the W. S. W. winds, mentioned before, in thoſe months of the year to be certain to the northward of the *Equator*. 5. That to the eaſtward of *Sumatra* and *Malacca*, to the northward of the *Line*, and along the coaſt of *Camboia* and *China*, the *Monſoons* blow north and ſouth; that is, the N. E. winds are much northerly, and the S. W. much ſoutherly: this conſtitution reaches to the eaſtward of the *Philippine* iſlands, and as far north as *Japan*; the northerly *Monſoon* ſetting in, in theſe ſeas, in *October* or *November*, and the ſoutherly, in *May*, and blowing all the ſummer months: Here it is to be noted, that the points of the compaſs, whence the winds blow in theſe parts of the world, are not ſo fixed, as in thoſe lately deſcribed; for the ſoutherly will frequently paſs a point or two to the eaſtward of the ſouth, and the northerly as much to the weſtward of the north; which ſeems to be cauſed by the great quantity of land interſperſed in theſe ſeas. 6. That in the ſame meridians, but to the ſouthward of the *Equator*, which is that tract lying between *Sumatra* and *Java* to the weſt, and *New-Guinea* to the eaſt, the ſame northerly and ſoutherly *Monſoons* are obſerved, but with this difference; that the inclination of the northerly is towards the N. W. and of the ſoutherly towards the S. E. but the points from which the winds blow are not more conſtant here than in the former, *viz.* variable five or ſix points; beſides, the times of the change of theſe winds are not the ſame as in the *Chineſe* ſeas, but about a month or ſix weeks later. 7. That theſe contrary winds do not ſhift all at once, but in ſome places the time of the change is attended with calms, in others with variable winds; and it is particularly remarkable, that the end of the weſterly *Monſoon* on the coaſt of *Coromandel*, and the two laſt months of the ſoutherly *Monſoons* in the ſeas of *China*, are very ſubject to be tempeſtuous; the violence of theſe ſtorms is ſuch, that they ſeem to be of the nature of the *Weſt-India* hurricanes, and render the navigation of theſe parts very unſafe about that time of the year; theſe tempeſts are by our ſeamen called the breaking up of the *Monſoons*; by reaſon of the ſhifting of theſe winds, ſuch as ſail theſe ſeas are obliged to obſerve the ſeaſons proper for their voyages; of which, if they chance to miſs, and the contrary *Monſoon* ſets in, they are forced to give over the hopes of accompliſhing their intended voyage, till the winds become favourable.

The third ocean, called *Mare Pacificum*, is of an extent equal to the other two; what *Spaniſh* writers ſay of the winds, they find in their courſe, and which is confirmed by the old accounts of *Drake* and *Cavendiſh*, and ſince by *Schooten*, who ſailed the whole breadth of this ſea in the S. Lat. of 15 or 16°, is, that there is a great conformity between the winds of this ſea, and thoſe of the *Atlantic* and *Ethiopic* ſeas; that is, that to the northward of the *Equator*, the predominant wind is between the eaſt and north-eaſt; and to the ſouthward thereof, there is a conſtant ſteady gale between the eaſt and ſouth-eaſt; and that on both ſides the *Equator*, with ſo much conſtancy, that they ſcarce ever need to attend the ſails; and with ſuch briſk gales, that they commonly croſs this vaſt ocean in ten weeks time, which is about 130 miles a day; beſides, it is ſaid, that neither ſtorms or tempeſts are ever known in theſe parts; wherefore ſome have thought the ſailing by the ſtreights of *Magellan* to be as ſhort to *Japan* and *China*, as by the *Cape of Good Hope*: The limits of theſe general winds are alſo much the ſame as in the *Atlantic* ocean, *viz.* about the 30th degree of latitude on both ſides; for the *Spaniards*, homewards bound from the *Manillas*, always take the advantage of the ſoutherly *Monſoon*, blowing there in the ſummer months, and they run up to the northward of that latitude, as high as *Japan*, before they meet with variable winds, to ſhape their courſe to the eaſtward: And *Schooten* and others, that have gone about by the ſtreights of *Magellan*, have found the limits of ſouth-eaſt winds, much about the ſame latitude to the ſouthward; beſides, a farther analogy between the winds of this ocean and the *Ethiopic*, appears from their being always ſoutherly, as they are found near the ſhores of *Angola*.

In the foregoing hiſtory are contained ſeveral problems, that deſerve well the conſideration of the acuteſt naturaliſts, both by reaſon of the conſtancy of the effect, and its vaſt extent: As firſt, why theſe winds perpetually blow from the eaſt in the *Atlantic*, *Ethiopic*, and *Pacific* oceans, between the latitudes of 30 north and ſouth. 2. Why the ſaid winds extend no farther with conſtancy than to the latitude of 30°. 3. Why there ſhould be a conſtant ſouth-weſterly wind upon and near the coaſt of *Guinea*. 4. Why in the north part of the *Indian* ocean, the winds, which for one half year do agree with thoſe of the other two oceans, ſhould change in the other half year, and blow from the oppoſite points; whilſt the ſouthern part of that ocean follows the general rule, and hath perpetual winds about ſouth-eaſt. 5. Why in theſe general trade winds, it ſhould always hold, that to the northward of the *Equator*, it is inclined to the northward of the eaſt; and in ſouth latitudes to the ſouthward thereof. 6. Why in the ſeas of *China*, there ſhould be ſo great an inclination from the eaſt to the north, more than elſewhere.

1. Wind is very properly defined, a ſtream or current of the air; and where ſuch ſtream is perpetual and fixed in its courſe, it is neceſſary that it proceed from a permanent unintermitting cauſe; wherefore, ſome have been inclined to propoſe the

diurnal rotation of the earth upon its axis; by which, as the globe turns eaſtwards, the looſe and fluid particles of the air, being ſo exceeding light as they are, are left behind, ſo that, in reſpect of the earth's ſurface, they move weſtwards, and become a conſtant eaſterly wind: This opinion would ſeem to be confirmed from theſe winds being only found near the equinoctial, in thoſe parallels of latitude, where the diurnal motion is ſwifteſt; did not the conſtant calms in the *Atlantic* ocean near the *Equator*, the weſterly winds near the coaſt of *Guinea*, and the periodical weſterly *Monſoons* under the *Equator* in the *Indian* ſeas, ſhew the inſufficiency of that hypotheſis; beſides the air, being kept to the earth by the principle of gravity, would acquire the ſame degree of velocity, that the ſurface of the earth moves with, as well in reſpect of the diurnal motion, as of the annual about the ſun, which is about thirty times ſwifter: It remains therefore to ſubſtitute ſome other cauſe, capable of producing a like conſtant effect, not liable to the ſame objections, but agreeable to the known properties of the elements of air and water, and the laws of the motion of fluid bodies; and ſuch ſeems to be the action of the ſun beams upon the air and water, as he paſſes every day over the ocean, taking in alſo the nature of the ſoil, and ſituation of the adjoining continents; firſt then, according to the laws of ſtatics, the air, which is leſs rarified, or expanded by heat, and conſequently more ponderous, muſt have a motion towards thoſe parts thereof, which are more rarified and leſs ponderous to bring it to an equilibrium; and ſecondly, the preſence of the ſun continually ſhifting to the weſtward, the part towards which the air tends, by reaſon of the rarifaction made by his greateſt meridian heat, is together with him carried weſtwards, and conſequently the tendency of the whole body of the lower air is that way: Thus a general eaſterly wind is formed, which being impreſſed upon all the air of a vaſt ocean, the parts impel one another, and ſo keep moving, till the next return of the ſun, whereby ſo much of the motion as was loſt, is again reſtored, and thus the eaſterly wind is made perpetual.

2. From the ſame principle it follows, that this eaſterly wind ſhould on the north ſide of the *Equator*, be to the northward of the eaſt, and in ſouth latitudes to the ſouthward thereof; for near the *Line*, the air is much more rarified, than at a greater diſtance from it; becauſe the ſun is twice a year vertical, and at no time farther off than 23° and a half; at which diſtance, the heat, being as a ſine of the angle of incidence, is

but little ſhort of that of the perpendicular ray; whereas, under the *Tropics*, tho' the ſun continue long vertical, yet he is for as long a time 47° off; which is a kind of winter, wherein the air is ſo cooled, as that the ſummer heat cannot warm it to the ſame degree with that under the *Equator*; wherefore the air, to the northward and ſouthward, being leſs rarified than that in the middle, it follows, that from both ſides it ought to tend towards the *Equator*: This motion, compounded with the former eaſterly wind, anſwers all the phænomena of the general trade winds, which, if the whole ſurface of the globe were ſea, would undoubtedly blow all round the world, as they are found to do in the *Atlantic* and *Ethiopic* oceans.

3. But ſeeing ſo great continents interpoſe and break the continuity of the ocean, regard muſt be had to the nature of the ſoil, and the poſition of the high mountains, which Mr. *Halley* ſuppoſes the two principal cauſes of the ſeveral variations of the winds from the former general rule; for if a country, lying near the ſun, prove to be flat, ſandy, low land, ſuch as the deſerts of *Lybia* are commonly reported to be; the heat, cauſed by the reflection of the ſun beams, and the retention thereof in the ſand, is incredible to thoſe that have not felt it; whereby the air being exceedingly rarified, it is neceſſary that this cooler and more denſe air ſhould run thither to reſtore the equilibrium; and this ſeems to be the cauſe, why near the coaſt of *Guinea* the wind always ſets in upon the land, blowing weſterly inſtead of eaſterly, there being ſufficient reaſon to believe, that the inland parts of *Africa* are prodigiouſly hot, ſince the northern parts thereof were ſo intemperate, as to give the ancients cauſe to conclude, that all, beyond the *Tropic*, was uninhabitable by exceſs of heat; from the ſame cauſe it happens, that there are ſo conſtant calms in that part of the ocean called the *Rains*; for this tract being placed in the middle, between the weſterly winds blowing on the coaſt of *Guinea*, and the eaſterly trade winds blowing to the weſtward thereof, the tendency of the air here is indifferent to either, and ſo ſtands *in equilibrio* between both; and the weight of the incumbent atmoſphere being diminiſhed by the continual contrary winds blowing from hence, is the reaſon that the air here holds not the copious vapours it receives, but lets them fall in ſo frequent rains.

4. But as the cool and denſe air, by reaſon of its greater gravity, preſſes upon the hot and rarified, it is demonſtrable, that this latter muſt aſcend in a continual ſtream, as faſt as it

rarifies, and after that it muſt diſperſe itſelf to preſerve the equilibrium; that is, by a contrary current, the upper air muſt move from thoſe parts, where the greateſt heat is; ſo by a kind of circulation, the N. E. trade wind below will be attended with a S. W. above, and the S. E. with a N. W. wind above: And that this is more than a bare conjecture, the almoſt inſtantaneous change of the wind to the oppoſite point, which is frequently found in paſſing the limits of the trade winds, ſeems to aſſure us; but what above all confirms this hypotheſis, is the phænomenon of the *Monſoons*, by this means very eaſily ſolved, and without it hardly explicable: Suppoſing therefore ſuch a circulation as above; it is to be conſidered, that to the northward of the *Indian* ocean there is every where land within the uſual limits of the latitude of 30°, *viz. Arabia, Perſia*, &c. which, for the ſame reaſon, as the midland parts of *Africa*, are ſubject to unſufferable heats, when the ſun is to the north, paſſing nearly vertical, but yet are temperate enough when the ſun is removed towards the other *Tropic*, becauſe of a ridge of mountains at ſome diſtance within the land, ſaid to be frequently in winter covered with ſnow, over which, the air, as it paſſes, muſt needs be much chilled; hence it happens, that the air, coming according to the general rule out of the N. E. in the *Indian Seas*, is ſometimes hotter, ſometimes colder, than that which by this circulation is returned out of the S. W. and by conſequence, ſometimes the under-current or wind is from the north-eaſt, and ſometimes from the S. W. That this hath no other cauſe, is clear from the times, wherein theſe winds ſet in; *viz.* in *April*, when the ſun begins to warm thoſe countries to the north, the ſouth-weſt *Monſoons* begin, and blow during the heats till *October*, when the ſun being retired, and all things growing cooler northwards, and the heat encreaſing to the ſouth, the north-eaſt winds enter and blow all the winter till *April* again.

5. And it is undoubtedly from the ſame principle, that to the ſouth of the *Equator*, in a part of the *Indian* ocean, the north-weſt winds ſucceed the ſouth-eaſt, when the ſun draws near the *Tropic* of *Capricorn*; but it muſt be confeſſed, that in this latter there occurs a difficulty, not eaſily accounted for, which is, why this change of the *Monſoons* ſhould be any more in this ocean than in the ſame latitudes in the *Ethiopic*, where there is nothing more certain than a ſouth-eaſt wind for the whole year.

6. It is likewiſe very hard to conceive, why the limits of the trade-winds ſhould be fixed about the 30th degree of latitude all round the globe, and that they ſhould ſo ſeldom fall ſhort of thoſe bounds; as alſo that in the *Indian* ocean, only the northern part ſhould be ſubject to the changeable *Monſoons*, and that in the ſouthern there ſhould be a conſtant S. E. wind.

A Dioptric Problem, why four Convex-Glaſſes *in a Teleſcope ſhew* Objects *erect; by Mr.* Will. Molyneux. Phil. Tranſ. N° 183. p. 169.

AS perſpectives of one convex-glaſs make objects appear upright, which thoſe of two convex-glaſſes invert, and again thoſe of three rectify, ſo it ſhould ſeem that thoſe of four ſhould invert; and yet experience ſhews that objects appear upright thro' theſe glaſſes.

According to Mr. *Molyneux*, this phænomenon appears eaſily explicable from the conſideration of placing glaſſes in a tube; which is thus, after the object-glaſs, the eye-glaſs is placed ſo much diſtant, towards the eye, from the *Focus* of the object-glaſs, as is the *Focus* of the eye-glaſs; then the middle eye-glaſs is placed at ſuch a diſtance from the *Focus* of the firſt eye-glaſs, as is the *Focus* of this middle eye-glaſs; laſtly, the neareſt eye-glaſs is placed ſo much diſtant from the *Focus* of this middle eye-glaſs, as is the *Focus* of this neareſt eye-glaſs; and the eye, looking thro' them all, is placed in the *Focus* of this neareſt eye-glaſs: Therefore, in the firſt place, one ſingle convex-glaſs cannot properly be ſaid by itſelf to ſhew objects erect or reverſed, but in reſpect of placing of the eye, that looks thro' it; for if the eye be placed nearer to it, than the *Focus* of the glaſs, the objects are erect; if the eye be placed juſt in the *Focus*, the objects are neither erect nor reverſed, but all in confuſion, and between both; and if the eye be placed farther from the glaſs than the *Focus*, the objects are reverſed; and here by diſtant objects are meant, the rays, flowing from any point of which, may be counted to come parallel towards the object-glaſs: Secondly, the object-glaſs of a teleſcope reverſes the object, both to the eye-glaſs and to the eye, that looks thro' it; for the eye-glaſs is placed farther from the object-glaſs than is the *Focus* of the object-glaſs; but the eye-glaſs contributes nothing towards the rectification or reverſion, the eye being placed juſt in its *Focus*: Thus we ſee, that the reverſing of objects in a teleſcope of two convex-glaſſes proceeds wholly from the object-glaſs and its poſition; and the eye-glaſs contributes

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butes nothing thereto; for were the eye itſelf in the place of the eye-glaſs, it would ſee the objects inverted thro' the ſingle object-glaſs: To come now to the ſecond eye-glaſs placed after the firſt, which is that next the object-glaſs, it is manifeſt, that if we place our eye nearer to this middle eye-glaſs than its *Focus*, the eye ſees the objects inverted and confuſed; place the eye in the *Focus*, the objects appear all in confuſion, and neither erect nor reverſed; for here again there is a diſtinct repreſentation of the objects to be received on a piece of paper, as in the *Focus* of the object-glaſs, and the eye, being ſituated at any time at this place, which is uſually called the diſtinct baſe, ſees all in confuſion; but then let the eye be placed farther from this middle-glaſs than its *Focus*; it perceives the objects erect and confuſed: Laſtly, the third or immediate eye-glaſs contributes nothing towards the erecting or reverſing the ſpecies, which it receives erect from the middle eye-glaſs, no more than in a teleſcope of two convex-glaſſes, the eye-glaſs contributes to the ſpecies it receives from the object-glaſs, as was ſhewn before: The reaſon, that this laſt or immediate eye-glaſs has nothing to do in the erecting or reverſing the ſpecies, is the ſame, as in a teleſcope of two convex-glaſſes, *viz.* the eye is placed in its *Focus*, and therefore ſees the ſpecies, as repreſented in the diſtinct baſe; that is, the ſpecies is inverted in the diſtinct baſe of the object-glaſs, and therefore a ſingle convex eye-glaſs brings it to the eye inverted; but in the diſtinct baſe of the middle, or ſecond eye-glaſs, the ſpecies is erect, and therefore the third or immediate eye-glaſs brings it to the eye erect: Wherefore we are to conſider the teleſcope, conſiſting of an object-glaſs and three eye-glaſſes, as two teleſcopes, each conſiſting of two convex-glaſſes; the firſt conſiſts of the object-glaſs and firſt eye-glaſs, and this inverts the ſpecies; that is, the ſpecies is inverted in the diſtinct baſe of the object-glaſs, and ſo brought to the eye; the ſecond teleſcope conſiſts of the two immediate eye-glaſſes, and this renders erect what the former inverted; that is the ſpecies in the diſtinct baſe of the middle eye-glaſs is erect, and is brought to the eye by the eye-glaſs; the eye-glaſſes themſelves, in neither caſe, having any thing to do with the erecting or inverting, but merely repreſenting in the ſame poſture the ſpecies immediately before them: Therefore, in the laſt place, one convex-glaſs, as poſited in a teleſcope, inverts; the ſecond, that is, the firſt eye-glaſs does nothing towards erecting or reverſing, but repreſents the image, as it is in the diſtinct baſe of the object-glaſs, that is inverted; the third glaſs erects, or rather reſtores, what was before inverted; the fourth repreſents the image as it receives it from the diſtinct baſe of the third, that is, erect.

The Velocity wherewith the Air *ruſhes into an exhauſted Receiver*; *by Dr.* Papin. Phil. Tranſ. N° 184. p. 193.

THE Royal Academy at *Paris* deviſed an experiment in order to diſcover the velocity of the air in proportion to the ſeveral preſſures it may undergo; and for this end they filled a bladder ſometimes with water, and ſometimes with air; and they found, that tho' the weight for ſqueezing out theſe fluids, and the hole for their diſcharge were the ſame, yet the bladder, when full of air, could be emptied in the 25th part of the time that was requiſite for emptying the water; whence they concluded, that the velocity of the air is 25 times greater than that of water; it is true, this experiment is very ingenious, but not entirely juſt; for air yields much, and ſo the bladder, being filled therewith, will become pretty flat, as ſoon as a conſiderable weight is laid upon it; it is plain therefore, that the weight, bearing upon a large ſurface, doth not preſs every part with the ſame force, as it would do, if the bladder did for a while remain diſtended, as it doth when full of water; beſides, the water itſelf, being heavy in the bladder, cauſes ſome preſſure; ſo that it appears, that the preſſure in this experiment was not quite ſo great upon the air, as on the water: Dr. *Papin* therefore bethought himſelf of another, founded on this hydroſtatical principle, that liquors can aſcend as high as their ſource; and altho' the reſiſtance of the medium doth always hinder *Jets d'Eau* in the open air, from reaching quite ſo high, yet the liquor, at its firſt diſcharge, hath the neceſſary ſwiftneſs to come to that height.

Prop. I. From this principle may be eaſily deduced this propoſition, *viz.* that of two different liquors driven by the ſame preſſure, that which is ſpecifically lighter muſt aſcend higher than that which is heavier, and their heights will be reciprocally in the ſame ratio, as their ſpecific gravities.

Prop. II. From the preceeding propoſition another may be eaſily deduced, *viz.* that of different liquors, ſuſtaining the ſame preſſure, thoſe ſpecifically lighter muſt acquire a greater ſwiftneſs, and their different velocities be to each other reciprocally as the roots of the ſpecific gravities of the ſaid liquors; for we have ſeen *Prop.* I. that the heights, to be attained, are reciprocally in the ſame ratio as the ſpecific gravities; now

Galileo, *Huygens*, and others have demonſtrated, that the velocities of bodies are to each other, as the ſquare roots of the heights to which they may aſcend; and ſo in this caſe they are alſo reciprocally as the roots of the ſpecific gravities: If therefore we would know, what is the velocity of air driven by any degree of preſſure whatſoever, we need only find the velocity of water under the ſame preſſure, and then take the ſquare roots of the ſpecific gravities of theſe two fluids; becauſe as much as the ſquare root of the ſpecific gravity of water doth exceed the ſquare root of the ſpecific gravity of air, ſo much in proportion will the velocity of air exceed the velocity of water; for inſtance, when Dr. *Papin* would calculate the ſwiftneſs of a bullet ſhot by his pneumatic engine, he, in the firſt place, computed the velocity of the air itſelf that drove the bullet; and he obſerved, that in this caſe the air ſuſtains a preſſure much the ſame with that of water, when raiſed to the height of 32 foot, and therefore, according to *Galileo*, *Huygens*, and others, ſuch water hath the velocity of 45 foot in a ſecond; what remains therefore, is only to know the proportion of the gravity of the air to that of water, which former is not always the ſame, becauſe the height, heat, and moiſture of the atmoſphere are variable; yet we may ſay in general, that the ratio of the ſpecific gravity of water to that of air, is about 140 to 1; taking then their ſquare roots, which are 29 and 1, we may conclude that the velocity of air muſt exceed that of water by 29 times; and ſo multiplying 45, the velocity of water, by 29, we ſhall find that the velocity of air, driven by the whole preſſure of the atmoſphere, is about 1305 foot in a ſecond.

The Diviſions of the Barometer; *by Dr.* Hook. Phil. Tranſ. N° 185. p. 241.

SINCE the diſcovery of the alterations in the weight of the atmoſphere by the means of the *Torricellian* tube, there have been ſeveral contrivances thought on, to make the more minute variations, in the preſſure of the air, ſenſible; and firſt, Dr. *Hook* invented the wheel-barometer; but this did not fully anſwer the deſigned exactneſs, both becauſe the mercury being apt to adhere to the ſides of the glaſs, would riſe and fall too ſuddenly at once; and becauſe it is very difficult to adjuſt the apparatus of this inſtrument; as alſo, that it is exceeding apt to be out of order, on which account, it is at preſent almoſt wholly laid aſide: Upon this Dr. *Hook* bethought himſelf of another device, which was to encreaſe the diviſions, by putting coloured ſpirits of wine, or ſome other liquors, not capable of freezing, on the mercury, which liquor was made to riſe, as the mercury fell, and fall as it roſe, in a narrow tube, ſo as that the utmoſt limits were about two foot aſunder; but yet he was not ſatisfied, till he had found out the means of encreaſing the diviſions of the barometer at pleaſure; as he did in the following manner: The cylinder A, Fig. 6. Plate XI. may be of what diameter you pleaſe, the bigger the better, but it need not be above two inches long; the tube A D muſt be ſo long that the upper part of the cylinder B may be 29 inches + ſuch a part of the height of the other tube B C, as the weight or ſpecific gravity of the liquor that is to fill that tube, is to the ſpecific gravity of mercury, below the line A B in the cylinder A; the third cylinder C may be as high as you pleaſe above the cylinder B, but is moſt conveniently made in ſuch a manner as that the ſquare of the diameter of the tube B C, be to the ſquare of the diameter of the cylinders B or C, which muſt be exactly equal, as the riſe of the mercury in the cylinder B, is to the whole length of the tube B C; for in this caſe there will be nothing ſuperfluous, but the diviſions will be enlarged to the utmoſt advantage: One way of filling this barometer, is to leave a ſmall hole at the top of the cylinder A, and another near the top of the cylinder B; this latter being well ſtopped, pour in as much mercury at the other hole in A, as ſhall fill both tubes as high as the level of the ſaid hole; which done, ſtop either, by hermetically ſealing it, or elſe by a drop of ſealing-wax in the hole A, the glaſs being firſt ground rough to make it ſtick; then opening the hole in B, draw off as much of the mercury of the tube B C, till it run no longer; after which, ſtop firmly the hole in B, and you will have the cylinder A evacuated of air, and the height of the mercury will be as is uſual in the ordinary plain and wheel-barometers: Then pour into the tube B C as much ſpirit of wine tinged with cochineel and oil of turpentine, equal parts of each, as ſhall ſtand above the ſurface of the mercury, ſo many feet as you make the enlarged ſcale of your barometer, or as is between the middle of the cylinders B and C; and you will find the mercury ſink in the tube B C, and riſe in the other A D, in ſuch proportion, that each 13 foot of oil and ſpirit, will raiſe the mercury ten inches; this done, you muſt pour on, by the tube B C, ſo much mercury as may fill up the cylinders A and B to ſuch heights, that the ſurface of the mercury in both, may, at the utmoſt limits, which have not in *England* been found to exceed 30, 6 and 28, 6 inches, always fall within the bodies of the cylinders, and never enter into the tubes: Here note, that thoſe liquors are choſen upon two accounts; firſt, they are nearly of a weight, and ſpirit of wine highly rectified is ſomewhat lighter than oil of turpentine, but by a very ſmall addition of water, the ſpirit will preponderate and be undermoſt; ſo that you may make them as near of a weight as you pleaſe, and conſequently a cylinder of the oil will inſenſibly differ from an equal cylinder of ſpirit of wine: Secondly, they are liquors that will not mix; ſo that the oil of turpentine, ſwimming on the top, will be divided only by a line from the tinged ſpirit of wine, which the oil will keep from evaporating: The effect of this barometer will be, that when the atmoſphere is heavy, and the mercury high in the cylinder A, and runs out of B, the ſpirit of wine will deſcend into the cylinder B, and the oil of turpentine fill the tube, ſo as to make the diviſion of the two liquors near the cylinder B; but on the contrary, when the air is light, the mercury will ſink in A and riſe in B, ſo as to drive the ſpirit of wine into the tube, and the oil of turpentine into the cylinder C, ſo that the ſection of the two liquors will be near C, and the variation of the height of the mercury will be enlarged into almoſt the length of the tube, without in the leaſt altering the counter-preſſure from the fluids, the height and weight of the incumbent cylinders being always the ſame: That little alteration that may happen by the dilatation and contraction of the ſpirit of wine by heat and cold, which ought to be accounted for, may be beſt diſcovered by a thermometer hanging by it, containing the ſame quantity of ſpirit of wine, and whoſe tube is as near as poſſible, of the ſame diameter with the tube BC in the barometer, whoſe deſcent and aſcent muſt be added and ſubſtracted to reduce it to a rigorous exactneſs; but it is ſtill worth while to enquire, whether the mercury itſelf doth not ſhrink and ſwell with cold and heat, ſo as not to require this correction.

A Method of Caſting Statues *of an extraordinary thinneſs; by M.* John Weichard Valvaſor. Phil. Tranſ. N° 186. p. 259.

IN the firſt place, M. *Valvaſor* formed out of good clay, that would endure the fire, and not crack either in drying or burning, any figure or ſtatue at pleaſure; when this was well dried, he made, all over the figure, ſmall holes of no great depth, ſtill proportioning both their ſize and depth to the bigneſs of the ſtatue; into theſe holes he put ſmall pieces of metal, and fixed them firmly therein with ſome of the ſame clay; the uſe of theſe bits of metal marked *a a a a* Fig. 1. Plate XII. was to keep the core and mould ftom touching each other, or falling together, when the wax runs out, and that they might remain conſtantly in the ſame fixed poſture: This done, he ſcraped away, with ſome proper inſtrument, as much of the clay in thickneſs, as he deſigned for the thickneſs of his ſtatue, and then laying it in a furnace, he burned the core till it became red hot, by the core is underſtood the ſtatue firſt made in clay; he rubbed the core all over, when cold, with that ſort of earth, or colour, uſed by *German* potters in colouring the joints of the tiles, when they ſet ſtoves of tiles, or *Kachel ofens*; this colour reſembles black lead, uſed in deſigning on paper, and is eaſily wiped out with bread, but is not the ſame; this colour he mixed with water, daubing the core all over with it, becauſe the metal would run freely upon it: This done, he laid upon the core as much yellow wax mixed with pitch or roſin, as would make the thickneſs of the intended ſtatue, which he formed in the wax, with all the exactneſs poſſible: Here note, that the particles of metal ſet into the core, to keep it at a diſtance from the mould, muſt be ſo ſet as to fall in exactly with the ſurface of the wax; and that the reaſon of mixing pitch or roſin with the wax is, becauſe that when it is burnt out, it makes a great ſmoke, and that ſmoke, adhering to the mould, cauſes the metal to run more freely: In the next place he put, all over on the ſurface of this ſtatue of wax, little pieces of wax, which he called the little channels *c c c c c c*, all which muſt be ſo contrived as to enter the great channels *d d d*; this done, he covered the core and wax all over with the ſame ſort of clay, that would endure the fire without cracking, and thus he had his concave ſtatue or mould made; upon this he laid the great channels marked *d d d d*, both upright and tranſverſe, formed likewiſe in wax, and placed ſo, as beſt to receive the ends of the little channels *c c c c c c*, for the more eaſy diſtribution of the metal: The great channels muſt all meet at the top of the ſtatue, in ſuch a manner as to come out by one hole, as at E, where the metal is to be poured in; it is alſo neceſſary to have a channel or two to let out the air as the metal enters, as thoſe marked *f f*, and there muſt be a whole or two left at the foot, as *g g*, where the great channels and waxen ſtatue join; and at which, when the mould is burnt, the wax as well of the ſtatue as of the channels may run out: The great channels being thus placed, the mould muſt be again laid over with the ſame ſort of clay; he conſtantly uſed to bind the mould about with iron wire and then lay on more clay, and when this mould was well dried, then he heated it red hot; and as he did the core before, ſo now both together: He burned the core firſt, that there might not need ſo great a fire to burn the mould as would melt the ſmall bits of metal; but for ſmall manageable ſtatues, of not above a foot or two high, they may be both burnt together, and there is no need of the holes *gg*, but the mould may be inverted, and the wax made to run out by the channels *ff* and E: The mould being thus burnt, he ſtopped with the ſame clay the two holes *gg*, and then buried it in a pit, and he proceeded as is uſual in caſting of bells and the like; but care muſt be taken that the metal be well melted: If it be a ſmall ſtatue, not above a foot or two high, whoſe mould may be managed in one's hands, then he made a concave ſtatue of wax of the thickneſs he deſired, and placed upon it all the great and ſmall channels as before; which done, he put it all together into a liquid ſubſtance made of plaiſter and tile or brick-duſt tempered with water: If the ſtatue be intended to be very thin, then he takes copper, and when it is well in fuſion he mixes with it a good quantity of zink, without obſerving any certain proportion of weight; the more zink, the better the metal runs; ſometimes for ſmall and thin ſtatues he put in above a third part of zink; and he found by experience that this mineral makes the metal run moſt freely, and gives it a fair golden colour: After the ſtatue is caſt, he takes off the mould, and cuts off all the little channels; both the great and ſmall channels are filled with metal, which may be kept for further uſe; and in theſe there is much more metal than in the whole ſtatue beſides; for, if the ſtatue be very thin, there muſt be more and bigger channels, and ſo the cheaper the ſtatue, the more weighty the channels are, and the more metal remains: To know the quantity of metal requiſite for any intended work, he takes a lump of the ſame mixture of wax and pitch, with which he made his mould for his ſtatue; and having weighed it, he makes a mould upon it, and caſts in the ſame a lump of metal of the ſame ſize, which he weighs, and thereby computes the proportion of the weight of the metal and wax; and then obſerving how many pounds of wax he uſed about the figure and channels, he could calculate nearly how much metal he ſhould melt.

The Meaſure of the Air's *Reſiſtance to* Bodies *moved therein; by Dr.* Wallis. Phil. Tranſ. N° 186. p. 269.

1. IN order to compute the reſiſtance of the air to all projectiles, this lemma is to be premiſed; *viz.* that, ſuppoſing other things equal, the reſiſtance is proportional to the celerity; for in a double celerity, there is to be removed, in the ſame time, twice as much air, which is a double impediment; in a triple, thrice as much, and ſo on in other ratio's: 2. Suppoſe we then the force impreſſed, and conſequently the celerity, if there were no reſiſtance, as 1, the reſiſtance as r, which muſt be leſs than the force, or elſe the force would not prevail over the impediment, to produce a motion; and therefore the effective force, at the firſt moment, is to be reputed as $1 - r$; that is, ſo much as the force impreſſed, is more than the impediment or reſiſtance: 3. Let it be as $1 - r$ to 1, ſo 1 to m, which m is therefore greater than 1: 4. And therefore the effective force, and conſequently the celerity, as to a firſt moment, is to be $\frac{1}{m}$ of what it would be, had there been no reſiſtance: 5. This $\frac{1}{m}$ is alſo the remaining force after ſuch firſt moment; and this remaining force is, for the ſame reaſon, to be proportionably abated as to a ſecond moment; that is, we are to take $\frac{1}{m}$ thereof, that is $\frac{1}{mm}$ of the impreſſed force; and for a third moment, at equal diſtances of time, $\frac{1}{mmm}$; for a fourth $\frac{1}{m^4}$; and ſo on *in infinitum*: 6. Becauſe the length diſpatched, in equal times, is proportional to the celerities; the lines of motion, anſwering to thoſe times, are to be as $\frac{1}{m}$, $\frac{1}{m^2}$, $\frac{1}{m^3}$, $\frac{1}{m^4}$, &c. of what they would have been, in the ſame times, had there been no reſiſtance: 7. This therefore is a geometrical progreſſion, and becauſe of m greater than 1, continually decreaſing: 8. This decreaſing progreſſion, infinitely continued, is yet of a finite magnitude and equal to $\frac{1}{m - 1}$ of what it would have been in ſo much time, if there had been no reſiſtance; for the ſum

or aggregate of a geometrical progreſſion is $\frac{UR-A}{R-1}$, ſuppoſing U the greateſt term, A the leaſt, and R the common multiplier, that is, $\frac{UR}{R-1}-\frac{A}{R-1}$: Now in the preſent caſe, ſuppoſing the progreſſion infinitely continued, the leaſt term A becomes infinitely ſmall, or $=0$; and conſequently $\frac{A}{R-1}$ doth alſo vaniſh, and thereby the aggregate becomes $=\frac{UR}{R-1}$; that is, by diviſion, $U+\frac{U}{R}+\frac{U}{R^2}+\frac{U}{R^3}$ &c. $=\frac{UR}{R-1}$; (ſuppoſing the progreſſion to begin at $U=1$) that is dividing all by R, that ſo the progreſſion may begin at $\frac{U}{R}=\frac{1}{m}$; $\frac{U}{R-1}=\frac{U}{R}+\frac{U}{R^2}+\frac{U}{R^3}$, &c. that is, in our preſent caſe, becauſe of $U=1$, and $R=m$, $\frac{1}{m}+\frac{1}{m^2}+\frac{1}{m^3}$ &c. $=\frac{1}{m-1}$; that is, putting $n=m-1$, $\frac{1}{n}$ of what it would have been, if there had been no reſiſtance. 9. This infinite progreſſion is fitly expreſſed by an ordinate in the exterior hyperbola, parallel to one of the aſſymptotes; and the ſeveral members of that, by the ſeveral members of this, cut in continued proportion; for let SH Fig. 2. Plate XII. be an hyperbola between the aſſymptotes, AB, AF, and let the ordinate DH, in the exterior hyperbola, parallel to AF, repreſent the impreſſed force undiminiſhed, or the line to be deſcribed in ſuch time by a celerity anſwerable to ſuch undiminiſhed force; and let BS, a like ordinate, be $\frac{1}{m}$ thereof; which therefore, being leſs than DH, as being equal to a part thereof, will be farther than it from AF: In AB, which is put $=1$, let B*d* be ſuch a part thereof as BS is of DH; now becauſe all the inſcribed parallelograms in the exterior hyperbola, AS, AH, &c. are equal, and therefore their ſides reciprocal; conſequently as $Ad=1-\frac{1}{m}$, ſuppoſing B*d* be taken from B towards A, is to $AB=1$, (or as $m-1$ to m) ſo is $BS=\frac{1}{m}$ DH to *d h*, which is therefore equal to $\frac{1}{m-1}$ of DH; that is, by diviſion, $\frac{1}{m}+\frac{1}{m^2}+\frac{1}{m^3}$ &c. of DH. Or, if B*d* be taken beyond B; then as A*d* $= 1+\frac{1}{m}$, is to AB $= 1$, or as $m+1$ to m, ſo is $\frac{1}{m}$ DH to *db*, which is therefore equal to $\frac{1}{m+1}$ DH; that is, by diviſion, $=\frac{1}{m}-\frac{1}{m^2}+\frac{1}{m^3}-\frac{1}{m^4}$ &c. of DH. 10. Let ſuch ordinate *db* Fig. 3, or its equal in the aſſymptote AF, be ſo divided in L, M, N, &c. by perpendiculars cutting the hyperbola in *l*, *m*, *n*, &c. as that FL, LM, MN, be as $\frac{1}{m}$, $\frac{1}{m^2}$, $\frac{1}{m^3}$, &c. that is, continually decreaſing in ſuch a manner, as that each antecedent be to its conſequent, as 1 to $\frac{1}{m}$, or as m to 1. 11. This is done by taking AF, AL, AN, &c. in ſuch proportion; for of continued proportionals the differences are alſo in continued proportion; for let A, B, C, D, &c. be ſuch proportionals, and their differences be, *a*, *b*, *c*, &c. that is $A-B=a$, $B-C=b$, $C-D,=c$, &c. Then, becauſe A, B, C, D, &c. are in continued proportion; by diviſion, $A-B:B::B-C:C::C-D:D$, &c. that is, $a:B::b:C::c:D$, &c. and alternately *a*. *b*. *c*. &c. : : B. C. D. &c. : : A. B. C. &c. that is in continued proportion, as A to B, or as m to 1. 12. This being done, the hyperbolic ſpaces F*l*, L*m*, M*n*, &c. are equal. 13. So that F*l*, L*m*, M*n*, &c. may fitly repreſent equal times, wherein unequal lengths are diſpatched, repreſented by FL, LM, MN, &c. 14. And becauſe they are in number infinite, tho' equal to a finite magnitude, the duration is infinite; and conſequently the impreſſed force, and motion thence ariſing, never to be wholly extinguiſhed, without ſome further impediment, but continually approaching to A, in the nature of aſſymptotes. 15. The ſpaces F*l*, F*m*, F*n*, &c. are therefore as logarithms, in arithmetical progreſſion increaſing, anſwering to the lines AF, AL, AM, &c. or to FL, LM, MN, &c. in geometrical progreſſion decreaſing. 16. Becauſe FL, LM, MN, &c. are as $\frac{1}{m}$, $\frac{1}{m^2}$, $\frac{1}{m^3}$, &c. infinitely terminated at A, therefore their aggregate FA or *db* is to DH, ſo much length, as would have been diſpatched in the ſame time by ſuch impreſſed force undiminiſhed, as 1 is to $m-1=n$. 17. If therefore we take, as 1 to n, ſo is AF to DH, this will repreſent the length to be diſpatched, in the ſame time, by ſuch undiminiſhed force. 18. And if ſuch D H be ſuppoſed to be divided into equal innumerable parts, and therefore infinitely ſmall; theſe anſwer to thoſe (as many) parts unequal in F A, or bd. 19. But what is the proportion of r to 1, or (which depends thereon) of $1-r$ to 1, or 1 to m remains to be enquired into by experiment. 20. If the progreſſion be not infinitely continued, but end (ſuppoſe) at N, and its leaſt term be A = M N; then out of $\frac{U}{R-1}=\frac{1}{m}+\frac{1}{m^2}+\frac{1}{m^3}$ &c. is to be ſubducted $\frac{A}{R-1}$, that is, as will appear by diviſion $\frac{A}{R}+\frac{A}{R^2}+\frac{A}{R^3}$, &c. that is, in our preſent caſe $\frac{a}{m}+\frac{a}{m^2}+\frac{a}{m^3}$, &c. and ſo the aggregate will be $\frac{1-a}{m}+\frac{1-a}{m^2}+\frac{1-a}{m^3}$, &c. $=\frac{1-a}{n}$: And this much as to the line of projection, in which, ſecluding the reſiſtance, the motion is reputed uniform, diſpatching equal lengths in equal times; conſider we next the line of deſcent. 21. In the deſcent of heavy bodies, it is ſuppoſed, that to each moment of time, there is ſuperadded a new impulſe of gravity to what was before; and each of theſe, ſecluding the conſideration of the reſiſtance of the air, proceed equally, from their firſt beginnings, thro' the ſucceeding moments. 22. Hence ariſes for the firſt moment 1, for the ſecond $1+1$, for the third $1+1+1$ and ſo on in arithmetical progreſſion; as are the ordinates in a triangle, at equal diſtances. 23. And ſuch are the continual increments of the diameter, or of the ordinates in the exterior parabola, anſwering to the interior ordinates, or ſegments of the tangent equally encreaſing. 24. If we take in the conſideration of the air's reſiſtance, we are then, for each of theſe equal progreſſions, to ſubſtitute a decreaſing geometrical progreſſion; in like manner, and for the ſame reaſons, as in the line of projection. 25. Hence ariſes for the firſt moment $\frac{1}{m}$, for the ſecond $\frac{1}{m}+\frac{1}{m^2}$, for the third $\frac{1}{m}+\frac{1}{m^2}+\frac{1}{m^3}$ &c. And ſuch is therefore the deſcent of a heavy body falling by its own weight; the ſeveral impulſes of gravity being ſuppoſed equal. 26. That is, as F L, F M, F N, &c. in the

$$\begin{array}{llll} \frac{1}{m} & & & \\ \frac{1}{m^2} & \frac{1}{m} & & \\ \frac{1}{m^3} & \frac{1}{m^2} & \frac{1}{m} & \\ \frac{1}{m^4} & \frac{1}{m^3} & \frac{1}{m^2} & \frac{1}{m} \end{array}$$

the line of deſcent, anſwering to F L, L M, M N, *&c.* in the line of projection. 27. But tho' the progreſſions for the line of projection are like to each of thoſe in the line of deſcent, it is not to be thence inferred, that therefore $\frac{1}{m}$ in the one is equal to $\frac{1}{m}$ in the other; but in the line of projection, ſuppoſe, $\frac{1}{m}f$ ſuch a part of the force impreſſed and a celerity anſwerable; in the line of deſcent $\frac{1}{m}g$; ſuch a part of the impulſe of gravity. 28. Thoſe for the line of deſcent of the ſame body are all equal, each to each; becauſe g, the new impulſe of gravity, in each moment is ſuppoſed to be the ſame. 29. But what the proportion of f to g is, or of the force impreſſed to the impulſe of gravity in each body, remains to be determined by experiment. 30. And this proportion being found as to one known force, the ſame is thence diſcovered as to any other force, whoſe ratio to this is given, in the ſame uniform medium. 31. And this being known as to one medium, the ſame is thence known as to any other medium, the ratio of whoſe reſiſtance to this is known. 32. If a heavy body be projected downwards in a perpendicular line, it deſcends therefore at the rate $\frac{1}{m}$, $\frac{1}{m^2}$, $\frac{1}{m^3}$, *&c.* of f, the impreſſed force, increaſed by $\frac{1}{m}$, $\frac{1}{m}+\frac{1}{m^2}$, $\frac{1}{m}+\frac{1}{m^2}+\frac{1}{m^3}$ *&c.* of g the impulſe of gravity, becauſe both forces are here united. 33. If projected perpendicularly upwards; it aſcends in the ratio of the former, abated by that of the latter; becauſe here the impulſe of gravity is contrary to the force impreſſed. 34. When therefore this latter, continually increaſing, becomes equal to the former, continually decreaſing, it then ceaſes to aſcend, and does thenceforth deſcend at the rate wherein the latter continually exceeds the former. 35. In an horizontal or oblique projection, if to a tangent whoſe increments are as F L, L M, M N, *&c.* that is, as $\frac{1}{m}f$, *&c.* be fitted ordinates at a given angle, whoſe increments are, as F L, F M, F N, *&c.* that is, as $\frac{1}{m}g$, *&c.* the curve, anſwering to theſe compound motions, is that wherein the projectile is to move. 36. This curve, being hitherto without a name, may be called *linea projectorum*, the line of projects, which reſembles a parabola deformed. 37. The celerity and tendency, as to each point of this line, is determined by a tangent to that point. 38. And that, againſt which, it makes the greateſt ſtroke or percuſſion, is that, which, at that point, is at right angles to that tangent. 39. If the projection, ¶. 25, be not infinitely continued, but terminate, ſuppoſe, at N, ſo that the laſt term in the firſt column be a; and conſequently in the ſecond, ma; in the third, mma, &c. each ſeries having one term leſs than that preceeding; then the aggregates of the ſeveral columns will be $\frac{1-a}{n}$, $\frac{1-ma}{n}$, $\frac{1-mma}{n}$, and ſo on, till (the multiple of a becoming $=1$) the progreſſion terminate. 40. Now all the abatements here, a, ma, mma, &c. are the ſame with the terms of the firſt column taken backwards; for a is the laſt, ma the next preceeding, and ſo of the reſt. 41. And the aggregate of all the numerators is ſo many times 1, as is the number of terms (ſuppoſe t) wanting the firſt column; that is, $t - \frac{1-a}{n}$, or $\frac{nt-1+a}{n}$, and this again, divided by the common denominator n, becomes $\frac{nt-1+a}{nn}$; and therefore $\frac{nt-1+a}{nn}g$ is the line of deſcent by its own gravity. 42. If therefore this be added to a projecting force downwards in a perpendicular, or ſubducted from ſuch projecting force upwards; that is, to or from $\frac{1-a}{n}f$; the deſcent, in the firſt caſe, will be $\frac{1-a}{n}f + \frac{nt-1+a}{nn}g$; and the aſcent in the other caſe $\frac{1-a}{n}f - \frac{nt-1+a}{nn}g$: And in this latter caſe, when the ablative part becomes equal to the poſitive part, the aſcent is at the higheſt; and thenceforth, the ablative part exceeding the poſitive, it will deſcend. 43. In an horizontal or oblique projection, having taken $\frac{1-a}{n}f$, in the line of projection, and thence (at the angle given) $\frac{nt-1+a}{nn}g$, in the line of deſcent; the point in the curve, anſwering to theſe, is the place of the project anſwering to that moment.

As to the queſtion, whether the reſiſtance of the medium does not always take off ſuch a proportional part of the force, as is the ſpecific gravity of the medium, to that of the body moved therein; Dr. *Wallis* thinks, this can by no means be admitted; for there are other things to be taken into conſideration; as for inſtance, a denſe medium will make a greater reſiſtance than one more rare, tho' of a like ſpecific gravity; and a ſharp arrow will make its way more eaſily thro' a medium, than a blunt-headed bolt, tho' of equal weight; and the ſame pyramid with the point, than with the baſe forwards: But this may be admitted, *viz.* that different mediums, equally fluid, other circumſtances being alike, do reſiſt in ſuch proportion, as is their ſpecific gravity; becauſe there is, in that proportion, a heavier project to be removed by the ſame force; which is one of the things, to which ¶. 31. refers: And again, the heavier project once in motion (being equally ſwift, and all other circumſtances alike) moves thro' the ſame medium in ſuch proportion more ſtrongly, as is its ſpecific gravity; for now the force is greater in ſuch proportion, for the removal of the ſame reſiſtance; and this is what in part is inſinuated in ¶. 30: But where there is a complication of theſe conſiderations, reſpect muſt be had to them all.

Cures *for* Mad Dogs, *or any* Animal *bit by them*; *by Sir* Rob. Gordon. Phil. Tranſ. N° 187. p. 298.

TAKE agrimony roots, primroſe roots, dragon roots, ſingle peony roots, the leaves of box, of each a handful; the ſtar of the earth (*Seſamoides Salamantica Parkinſoni*, or *Lychnis Viſcoſa Flore Muſcoſo* B. in *Engliſh*, called *Spaniſh Catch-Fly*) two handfuls; the black of crab's claws prepared, *Venice* treacle, of each one ounce; all theſe are to be beaten and bruiſed together, and boiled in about a gallon of milk, till half is boiled away; then put it unſtrained into a bottle, and give about three or four ſpoonfuls of it at a time for three mornings ſucceſſively, before new and full moon, to the dog, or animal: It will be neceſſary to take away a little blood the day before you adminiſter the medicine: Some of theſe roots and herbs being hard to be got in the winter, they may be gathered in their ſeaſon, and when dried and well powdered, may be given mixed with the crab's claws and *Venice* treacle, with ſallad oil or butter, and it will do as well: For men or women, that are bitten by mad dogs, take the ſame ingredients in the ſame quantities, and the roots and herbs being bruiſed all together, with the crab's claws and *Venice* treacle, let them be infuſed warm in two quarts of ſtrong white wine, for at leaſt 12 hours; this being ſtrained, the patient is to take about a quarter of a pint evening and morning, three days before the new and full moon; it may be ſweetned either with ſugar or ſome cordial ſyrup.

The Theory of the five Satellites *of* Saturn *corrected; by. M.* Caſſini. Phil. Tranſ. N° 187. p. 299. *Tranſlated from the* French.

THE diſtance of the firſt ſatellite from the centre of *Saturn* appeared variable, and its motion ſenſibly unequal, being ſwifter in the occidental ſemicircle than in the oriental: At length M. *Caſſini* determined its mean diſtance at $\frac{32}{40}$ of the diameter of *Saturn*'s ring, its diurnal motion at 6 ſ. 10° 41′ 31″; ſo that, if its motion were uniform, the duration of its conjunction with *Saturn*, that is, the whole time it ſpends in running over its ring, would be 7 h. 46′; it is to be noted, that M. *Caſſini* could not obſerve this ſatellite any nearer *Saturn* than $\frac{1}{4}$ of the *Anſæ:* He calculated the *Epocha* of its motion for the laſt of *December* 1685, at noon, to the meridian of *Paris* in *Capricorn* 24° 50′.

The diſtance of the ſecond ſatellite from the centre of *Saturn* appeared more uniform, and it was determined at 1 $\frac{1}{4}$ diameter of the ring; its motion alſo appeared more equal, and its diurnal motion was found 4 ſ. 11° 31′ 30″; ſo that the duration of its conjunction ſhould be 8 h. 36′: M. *Caſſini* could never obſerve it nearer the ring of *Saturn* than $\frac{1}{4}$ of the *Anſæ*; and as this ſatellite was for the moſt part to be ſeen within the confines of the diſtance of the firſt, to which it is equal in magnitude, and alike in colour, it proved a very difficult matter to diſtinguiſh them: The *Epocha* of this ſatellite was determined for the 31ſt of *December* 1685, at noon, in *Virgo* 9° 10′.

The diſtance of the third from the centre of *Saturn* appeared to be 1 $\frac{3}{4}$ of the diameter of the ring; its diurnal motion 2 ſ. 18° 41′ 50″; ſo that its conjunction ſhould laſt for 10 hours; the *Epocha* of its motion for the noon of the laſt day of 1685 *Virgo* 9° 39′.

The diſtance of the fourth ſatellite from the centre of *Saturn* was 4 diameters of the ring; its diurnal motion 22° 34′ 38″; the duration of its conjunction 15 h. 6′; the *Epocha* of its motion for the ſame time and place with the others in *Piſces* 18° 1′.

The diſtance of the fifth ſattellite from the centre of *Saturn*, was 12 diameters of the ring; its diurnal motion 4° 32′ 17″; its conjunctions continue for 24 hours; the *Epocha* for the ſame time and place in *Piſces* 16° 19′: From which elements tables and ephemerides may be conſtructed.

The apparent Magnitude of Celeſtial Objects, *when near the Horizon, and at a greater Altitude; by Mr.* Will. Molyneux. Phil. Tranſ. N° 187. p. 314.

IT is well known, that the mean apparent magnitude of the moon is 30′ 30″; but we will take it in round numbers to be 30′ at a full moon in the middle of winter, and when ſhe is in the meridian, and at her greateſt northern latitude, and conſequently the utmoſt at which ſhe can be elevated in our horizon; it is alſo well known, that when ſhe is in this poſition, and viewed by the naked eye, ſhe appears about a foot broad; but the ſame moon looked on, juſt as ſhe riſes, appears to be three or four foot broad, and yet if with an inſtrument we take her diameter, both in one poſition and the other, we ſhall find that ſtill ſhe is but 30′.

The celebrated *Des Cartes* attributes this appearance rather to a deceived judgment than to any natural affection of the organ, or medium of ſenſe; for the moon, ſays he, being near the horizon, we have a better opportunity and advantage of making an eſtimate of her, by comparing her with the various objects that affect the ſight in its way towards her; ſo that tho' we imagine ſhe looks bigger, yet it is a meer deception; for we only think ſo, becauſe ſhe ſeems nearer the tops of trees, chimneys, or houſes, or a ſpace of ground, to which we can compare her and eſtimate her thereby; but when we bring her to the teſt of an inſtrument, then we find our eſtimate wrong, and our ſenſes deceived: But if this were the caſe, we may at any time encreaſe the apparent magnitude of the moon, tho' in the meridian; for it would be only getting behind a cluſter of chimneys, a ridge of hills, or the tops of houſes, and comparing her to them in that poſition, as well as in the horizon; beſides, if the moon be viewed, juſt as ſhe riſes from the horizon terminated by a ſmooth ſea, and which has no more variety of objects to compare her to, than the pure air, yet ſhe will ſeem as large, as if viewed over the rugged top of an uneven tower, or rocky country; moreover, all variety of adjoining objects may be taken off, by looking thro' an empty tube, and yet the deluded imagination is no ways helped thereby.

The famous *Thomas Hobbes* gives this ſolution; let the point G, Fig. 4. Plate XII. be the centre of the earth, and F the eye on its ſurface; on the ſame centre G ſweep two arches, one as E H repreſenting the atmoſphere, and the other A D that azure ſurface, wherein we imagine the fixed ſtars to be, and let F D be the horizon; divide the arch A D into three equal parts, by the lines B F, C F; it is manifeſt, that the angle A F B is greater than the angle B F C, and this again is greater than the angle C F D; wherefore, ſays he, to make the angle C F D equal to the angle C F B, the arch C D muſt be greater than the arch C B; and conſequently, that the moon may in the horizon appear under the ſame angle, as when elevated, ſhe muſt cover a greater arch, and therefore ſeem greater; that is, the moon in the meridian appearing under the angle B F C, that ſhe may appear under an equal angle in the horizon; as ſuppoſe C F D, it is neceſſary the arch C D be greater than C B; and conſequently, tho' ſhe appear to ſubtend a greater arch, when in the horizon, than when elevated, yet ſhe appears under the ſame angle, and all this without refraction: The geometry of this figure is moſt certainly true and demonſtrable, but it makes no more to our preſent difficulty, than if nothing at all had been ſaid: For Mr. *Hobbes* has made the circle G F, repreſenting the earth, very large in proportion to the circle A D; and then indeed, taking the point F in the earth's ſurface, and by lines from thence dividing the angle A F D into any number of equal parts, the intercepted arches A B, B C, C D will be unequal: But if he had conſidered, that the earth is, as it were, a point in reſpect of the ſphere of the fixt ſtars; nay, that in reſpect of the *Orbis magnus* itſelf, or annual orbit of the earth, it is almoſt imperceptible; he would have found that the lines F B, F C, F D muſt be all conceived as drawn from the point G, and then equal angles will intercept equal arches, and on the contrary; and ſo it happens, at leaſt as to ſenſe, to the eye on the ſurface of the earth; ſo that his drawing his lines ſo far from G as F is, and to another concentric circle ſo near as A D, deceived him in this point.

The famous *Gaſſendus* hath written four large epiſtles on this ſubject, the ſubſtance of which is, that the moon, being near the horizon, and viewed thro' a more foggy air, caſts a weaker light, and conſequently affects not the eye ſo ſtrongly as when brighter; and therefore the *Pupilla* enlarges itſelf the more, thereby tranſmitting a larger projection on the *Retina*:

A certain *French Abbé* adopts this ſentiment of *Gaſſendus*, with this addition, that this contracting and enlarging of the *Pupilla* cauſes a different ſhape in the eye; an open pupil making the cryſtalline flatter, and the eye longer; and a narrower pupil ſhortening the eye, and making the cryſtalline more convex; the former is the caſe of our looking at remote objects; the latter, that of viewing objects near at hand; likewiſe an open pupil and flat cryſtalline accompany objects of a gentler light, whilſt objects of more forcible rays require a greater convexity and a narrower pupil: From theſe poſitions, the *Abbé* endeavours to account for the phænomenon in the following manner, *viz.* when the moon is near the horizon, by comparing her with interpoſing objects, we are to imagine her much farther from us than when more elevated; and therefore, ſays he, we diſpoſe our eyes, as for viewing an object farther from us; that is, we enlarge the pupil a little, and thereby make the cryſtalline flatter; moreover, the duſkineſs of the moon, in that poſition, does not ſo much ſtrain the ſight, and conſequently the pupil will be larger, and the cryſtalline flatter: Hence, a larger image will be projected on the bottom of the eye, and therefore the moon will appear larger; but the moon's imaginary diſtance and duſkineſs gradually vaniſhing as ſhe riſes; a different ſpecies is hereby introduced into the eye, and conſequently ſhe ſeems gradually leſs and leſs, till again ſhe approaches near the horizon: Theſe two opinions of *Gaſſendus* and the *Abbé*, being ſo near a-kin, may be conſidered together: And firſt, a wider or narrower aperture of the pupil neither encreaſes nor diminiſhes the projection on the *Retina*: It is true, *Honoratus Faber*, in his *Synopſis Optica*, endeavours to prove the contrary to this, and that in the following manner; AB, Fig. 5, is an object; EF the greater aperture of the pupil, admitting the projection KI on the *Retina*, whereas the leſſer aperture CD admits only the projection GH; but GH is leſs than KI, wherefore a ſmaller aperture diminiſhes the projection: It is ſurpriſing, that *Honoratus Faber*, who undertook to write of optics more accurately than any who went before him, ſhould be guilty of ſo very groſs an error; and that the celebrated *Gaſſendus* and the noble *Hevelius* ſhould be of the ſame opinion; for tho' the aforeſaid demonſtration hold moſt certainly true in direct projections, as in a dark room with a plain hole; yet it will not hold in projections made by refraction, as is the caſe in thoſe on the *Retina*, by means of the cryſtalline, and other humours and coats of the eye; for let A B, Fig. 6, be a remote object, and E F the cryſtalline, at its large aperture, projecting the image I M on the *Retina*: Let then C D be the ſmaller aperture of the pupil before the cryſtalline, the image I M will be projected as large as before; for the cone of rays E A F conſiſts partly of the cone of rays C A D; therefore, where the former E A F is projected, the latter C A D, as being a part of the former, will be alſo projected; ſo that no more is effected by this narrow aperture, but only that the ſides of the radiating cones are intercepted, and conſequently the point I will be affected with leſs light, but it will ſtill be in the ſame place; what is ſaid of that cone and that point, may be ſaid of all other cones and other points of the object: From hence appears, firſt, the invalidity of the account given of the moon's appearance by *Gaſſendus*: Secondly, the reaſon appears, why a teleſcope's greater or ſmaller aperture makes no difference in the angle it receives; for imagine E F to be an object-glaſs of a teleſcope, and the thing is plain: Thirdly, it is evident why a greater or ſmaller aperture in a teleſcope ſhould make the objects appear brighter or darker; for thereby more or fewer rays are admitted for defining the projection of each point: And this is ſufficient for a confutation of *Gaſſendus* and *Faber*: But the *Abbé* ſuperadds, to a greater or ſmaller aperture of the pupil, as a neceſſary conſequence, a greater and leſſer convexity of the cryſtalline, as alſo a lengthening and ſhortening of the tube of the eye; this might be ſomething to the purpoſe, if we found it true in our caſe: Firſt, ſays he, the duſkiſhneſs of the moon near the horizon ſuffers the pupil to enlarge itſelf, the cryſtalline to flatten, and the eye to lengthen itſelf; but what if we change our object, and inſtead of the moon take the diſtance between ſome of the fixed ſtars, as ſuppoſe, thoſe of *Orion*'s girdle, and we ſhall find the ſame phænomenon in them, and yet it cannot be ſaid, that they at one time ſtrain the eye more than at another; or that at any time, their brightneſs ſtrains the eye at all; but perhaps it will be aſſerted, that this other reaſon holds, which is, ſecondly, that the greater imaginary diſtance, at which we fancy the moon near the horizon, than when more elevated, makes us view her, as if really ſhe was ſo, *viz.* with enlarged pupils, *&c.* But this has been ſufficiently refuted in the remarks on *Des Cartes*; and if there were any thing in this ſurmiſe, the horizontal moon ſhould rather be fancied nearer to, than farther from us.

Riccioli in his treatiſe of *Refraction*, aſſerts, that he and father *Grimaldi* had often taken the horizontal ſun and moon's diameters by a ſextant, and that they always found the diameters larger than when more elevated; the ſun often ſubtending an angle of almoſt a degree, and frequently 45′; the moon alſo 38 or 40′: This is directly repugnant to the matter of fact above alledged; and whoever is in the right, muſt be determined by accurate experiments; only had *Riccioli*'s experiments been nicely proſecuted, he ſhould have tried them, when the horizontal moon had appeared ten times larger in diameter than ordinary; and then if it be true, that even by an inſtrument ſhe ſhall be found proportionably broader than really ſhe is, ſhe ſhould ſubtend an angle of 300′ or 5°; for very often Mr. *Molyneux* had obſerved the moon ten times broader than ordinary; which the ſmall addition of 8 or 10′ to her uſual diameter could never cauſe.

The preceeding Phænomenon *conſidered; by Dr.* Wallis. Phil. Tranſ. N° 187. p. 323.

THO' refraction near the horizon alter the altitude of an object, yet not its azimuth; for ſince this equally reſpects all points of the horizon, let the refraction be what it will, the whole horizon can be but a circle; ſo that there is no room for the breadth of a thing, as to the angle at the eye, to be made larger, whatever its height may be, the refraction not equally affecting all parts in the circles of altitude; nor is there any reaſon, why this ſhould rather thruſt the other, than the other this, out of its place; whereas in the altitude, it is otherwiſe; for while what is near the horizon is enlarged, that which is farther off is thereby contracted; which, as to the azimuth or horizontal poſition does not hold: Suppoſing then, that the ſun's apparent horizontal diameter taken by inſtrument, is the ſame near the horizon, that it is in a higher poſition, Dr. *Wallis* takes its imaginary magnitude near the horizon to be only a deception of the eye, or rather of the imagination from the eye; for the imagination doth not eſtimate the magnitude of the object only by the angle it makes at the eye, but by this compared with the ſuppoſed diſtance; and all other things being equal, we judge that to be the greater object which makes at the eye the greater angle; but not ſo, if apprehended at different diſtances; for, if through a caſement, or ſmaller aperture, we ſee a houſe at one hundred yards diſtance, this houſe, though ſeen under a leſs angle, doth not to us ſeem leſs than the caſement, thro' which we view it, or this greater than that, becauſe it makes at the eye the greater angle, but the imagination makes a comparative eſtimate from the angle and diſtance jointly conſidered: So that of two things ſeen under the ſame or equal angles, if one of them have ought that cauſes the apprehenſion of a greater diſtance, that to the imagination will appear larger: Now it is certain, that one great advantage, for eſtimating the diſtance of a thing ſeen, is from the variety of intermediate objects between the eye and the thing ſeen: Now when the ſun or moon is near the horizon, there is a proſpect of hills, valleys, plains, woods, rivers and variety of fields and encloſures between them and us, which preſent to our imagination a great diſtance capable of receiving all theſe; or, if it happen that theſe intermediate objects are not actually ſeen, yet having been accuſtomed to ſee them, the memory ſuggeſts to us a view as large as is the viſible horizon: But when the ſun or moon are in a higher poſition, we ſee nothing between us and them, unleſs perhaps ſome clouds, and therefore nothing to preſent to our imagination ſo great a diſtance as the other; and conſequently, tho' both be ſeen under the ſame angle, they do not appear to the imagination of the ſame magnitude, becauſe they are not both fancied to be at the ſame diſtances; but that near the horizon is judged bigger, becauſe ſuppoſed farther of, than the ſame when at a greater altitude: It is true that as to ſmall and ordinary diſtances, beſides this eſtimate from intermediate objects, the eye hath a means within itſelf of making ſome eſtimate of the diſtance; as when we already know the magnitude of an object, to which we have been accuſtomed, as a man, a tree, a houſe, or the like; if ſuch things appear to us under a ſmall angle, indiſtinct and faintly coloured, the imagination doth allow of ſuch diſtance, as to make ſuch a thing ſo to appear; and if this, thro' a proſpective glaſs, be repreſented to us under a bigger angle, and more diſtinct, it is accordingly apprehended as ſo much nearer; but the caſe is otherwiſe, when we do nor, by the known magnitude, judge of the diſtance; but, by the ſuppoſed diſtance, judge of the magnitude, as in the preſent caſe; and accordingly, different perſons, according to different fancied diſtances, judge very differently: Again, in our two eyes, when the object is ſeen by both, there is yet another means of eſtimating how far it is off; *viz.* there are, from the ſame object, two different viſual cones, terminated at the two eyes, whoſe two axes contain at the object, different angles, according to the different diſtances; as an acuter angle at a greater diſtance, and a more obtuſe one at a nearer diſtance: Now, that ſuch object may be ſeen clearly by both eyes, it is requiſite that the eyes be put in ſuch a poſition, as that the ſight of each eye receive the reſpective axis at right angles; which requires a different poſition of the two eyes, according to the different diſtance of the object; as will manifeſtly appear, if we look with attention on a finger, or other ſmall object, at two or three inches diſtance from the eye, and then upon another like object at 3 or 4 yards beyond it, and this alternately ſeveral times; for it will be manifeſt, that while we look intently on the one, we do not ſee the other, or but confuſedly; tho' both be juſt before us; and as we change our view, from the one to the other, we manifeſtly feel a motion of the eyes from one poſition to another: And according to the different poſition of the eyes, requiſite to a diſtinct viſion by both, we eſtimate the diſtance of the object from us; and hence it is that they, who have loſt the ſight of one eye, are at a great diſadvantage, as to eſtimating diſtances, from what they could do, whilſt they had the uſe of both: But now when the diſtance grows ſo great, as that the poſition of theſe viſual axes become parallel, or ſo near to parallel, as not to be diſtinguiſhable from it, this advantage is loſt, and we can thenceforth only conclude, that it is far off, but not how far: Hence it is, that our ſight can make no diſtinction of the moon's diſtance from that of the other planets, or even of the fixed ſtars; but they ſeem to us as equally remote, tho' we otherwiſe know their diſtances from us to be vaſtly different: And therefore there being nothing to aſſiſt the fancy in eſtimating ſo great a diſtance, but only the intermediate objects; where theſe intermediate objects appear to the eye, as when the ſun or moon are near the horizon, the diſtance is fancied greater than where they appear not, as when farther from it; and conſequently, tho' both under the ſame or equal angles, that near the horizon is fancied the greater; and this ſeems to be the true reaſon of that appearance.

The Conſtruction of Cubic and Biquadratic Equations *by a* Parabola *and a* Circle; *by Mr.* Edm. Halley. Phil. Tranſ. N° 188. p. 335. *Tranſlated from the* Latin.

HOW all equations, that involve the third or fourth power of the unknown quantity, may be conſtructed by means of any given parabola and a circle, *Des Cartes* hath ſhewn and clearly demonſtrated in the third book of his geometry; but firſt he directs to throw out the ſecond term of the equation, if ſuch there be, and then by a rule there given, to find the roots of the equation ſo reduced: But ſince that operation appeared too laborious, ſome deviſed a like conſtruction, without any ſuch previous reduction; amongſt whom *Franciſcus a Schooten* might be thought to have diſcovered a very eaſy and ſimple method for conſtructing cubic equations howſoever adfected, if by unfolding the principle from whence he derived his rule, he had had a greater regard for the memory of his readers, which he overcharges with many perplexed cautions: But our countryman Mr. *Thomas Baker*, in an entire treatiſe written on theſe conſtructions, has compriſed in one general rule not only cubic but alſo biquadratic equations of any kind; and this rule he hath ſufficiently illuſtrated by demonſtrations and examples in all caſes; and towards the end he ſubjoined a method of inveſtigating that general rule; but he has not ſhewn the very method, by means of which he obtained his *Univerſal Geometrical Clavis*, or at leaſt might have obtained it with much more eaſe; and ſince this rule of *Baker*'s is no leſs perplexed with cautions about the ſigns + and — than that of *Schooten*, ſo that no body can hardly pretend to do theſe conſtructions aright without having the book by him; Mr. *Halley* thought it would neither be unpleaſant nor unprofitable to young ſtudents, to explain the foundations of both, and by ſome amendment of the method, to clear up as much as poſſible ſo difficult a ſubject: *Des Cartes* conſtruction, which very eaſily diſcovers the roots of all cubic and biquadratic equations, where the ſecond term is wanting, may be ſuppoſed as known; but as it is the hinge to what is to follow, it may not be improper to add here his rule, with ſome alterations for the better: When the ſecond term is wanting, all cubic equations are reduced to this form $z^3 * apz. aaq = 0$; and biquadratic ones to this form $z^4 * apzz. aaqz. a^3 r = 0$, where *a* denotes the *Latus Rectum* of any given parabola, uſed in the conſtruction; or elſe, taking *a* for unity, the equations are reduced to theſe forms; *viz.* $z^3 * pz.\, q = 0$ or $z^4 * pzz.\, qz.\, r = 0$: Now the parabola F A G Fig. 7. Plate XII. being given, whoſe axis is A C D K L, and *Latus Rectum* a or 1, let A C be taken $= \frac{1}{2} a$, and let it be always ſet off from the vertex A towards the inner parts of the figure; then take C D $= \frac{1}{2} p$. in that line A C produced towards C, if it be $-p$. in the equation, or towards the contrary point, if it be $+p$: Moreover, from the point D, or C, if the quantity p be not in the equation, D E $= \frac{1}{2} q$ is to be erected perpendicular to the axis, to the right hand, if it be $-q$, but on the other ſide of the axis, if it be $+q$; and then a circle deſcribed on the centre E with the radius A E, if it be only a cubic equation, will interſect the parabola in as many points F and G, as the equation hath true roots, of which the affirmative ones, as G K, will be on the right ſide of the axis, and the negative ones as F L on the left: But if the equation be a biquadratic, the radius of the circle ſhould be either augmented or diminiſhed, by adding, if it be $-r$, or ſubtracting, if $+r$, the rectangle ar from its ſquare, which rectangle is the product of the *Latus Rectum* and the given quantity r, which is very eaſily done geometrically: And the interſections of this circle with the parabola will give, letting fall from them perpendiculars to the axis, all the true roots of the biquadratic equation, the affirmative on the right ſide of the axis, and the negative on the left: Here it is to be obſerved, that Mr. *Halley* endeavours to have the affirmative roots on the right ſide of the axis, to avoid the confuſion neceſſarily ariſing from a great number of cautions, where their reaſon is not evident.

Having premiſed theſe things, in order to make way for the conſtruction of theſe equations, where the ſecond term is found we are to conſider the rule for taking away the ſecond term, and reducing the equation to another, ſuch as might be conſtructed by the preceeding method: Now all cubic equations of this claſs are reducible to this form, $z^3.\, bzz.\, apz.\, aaq. = 0$, or to this, $z^3.\, bzz.\, *.\, aaq = 0$; biquadratic equations to this form, $z^4.\, bz^3.\, ap\, z^2.\, aaqz.\, a^3 r. = 0$, or to this, $z^4.\, bz^3.\, *.\, aaqz.\, a^3 r = 0$, or, $z^4.\, bz^3.\, apz^2.\, *.\, a^3 r = 0$, or in fine to this form, $z^4.\, bz^3.\, *.\, *.\, a^3 r = 0$; from all which there ariſes a great variety, according as the ſigns + and — are differently connected; and hence the general rule ſerving for all theſe caſes is rendred very obſcure and difficult, unleſs it be cleared up by the following method, and freed from its intricacies: The ſecond term in biquadratic equations is taken away by putting $x = z + \frac{1}{4} b$, if it be $+ b$ in the equation; or $x = z - \frac{1}{4} b$, if it be $- b$; hence $x - \frac{1}{4} b$ in the firſt caſe, and $x + \frac{1}{4} b$ in the ſecond, is $= z$; and in any propoſed equation ſubſtituting inſtead of z, its equal, there will ariſe a new equation, wanting the ſecond term, all whoſe roots x do either exceed or come ſhort of the ſought roots z, by the given difference $\frac{1}{4} b$.

Example 1. $z^4 + bz^3 - apzz - aaqz + a^3 r = 0$, put $x - \frac{1}{4} b = z$, and it will be,

$$x^2 - \tfrac{1}{2} bx + \tfrac{1}{16} bb = zz$$
$$x^3 - \tfrac{3}{4} x^2 b + \tfrac{3}{16} xbb - \tfrac{1}{64} bbb = z^3, \text{ and}$$
$$x^4 - bx^3 + \tfrac{3}{8} bbxx - \tfrac{1}{16} b^3 x + \tfrac{1}{256} b^4 = z^4.$$

Hence,
$$\begin{aligned} x^4 - bx^3 + \tfrac{3}{8} bbxx - \tfrac{1}{16} b^3 x + \tfrac{1}{256} b^4 &= z^4. \\ + bx^3 - \tfrac{3}{4} bbxx + \tfrac{3}{16} bbbx - \tfrac{1}{64} b^4 &= + bz^3. \\ - apxx + \tfrac{1}{2} apbx - \tfrac{1}{16} apbb &= - apz^2. \\ - a^2 qx + \tfrac{1}{4} a^2 qb &= - aaqz. \\ + a^3 r &= + a^3 r. \end{aligned}$$

The ſum of all theſe is a new equation, wanting the ſecond term, and which conſequently may be conſtructed by *Cartes*'s rule, by taking, inſtead of $\frac{1}{2} p$, the half of the co-efficient of the third term, divided by a or the parameter, that is $\frac{3bb}{16a} = \frac{1}{2} p$; and inſtead of $\frac{1}{2} q$, half the co-efficient of the fourth term, divided by aa, that is $+ \frac{bbb}{16aa} + \frac{pb}{4a} - \frac{1}{2} q$; the members of which, that have the ſign $+$, are to be ſet off to the left hand from the axis, and thoſe, that have the ſign $-$ to the right, in order to find the centre of the circle required for the conſtruction, and whoſe interſections with the parabola, letting fall perpendiculars to the axis, may give all the true roots x; *viz*. the affirmative on the right ſide of the axis, and the negative on the left: But when $x - \frac{1}{4} b = z$, then drawing a line parallel to the axis, on the right ſide of it, and at the diſtance of $\frac{1}{4} b$, the perpendiculars terminated by this parallel, will denote all the ſought roots z; *viz*. the affirmative to the right, and the negative to the left; as to the radius of the circle, it is had, by adding the negative, and taking away the affirmative parts of the fifth term divided by aa, from the ſquare of the line A E, drawn from the centre E found, to A the vertex of the parabola; which is moſtly done, by taking, inſtead of A E, the line E O, terminated at O, the interſection of the parabola and the above mentioned parallel; for its ſquare

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comprehends all the parts of the fifth term, brought into the new equation, upon the caſting out of the ſecond term, as is eaſily proved; and it only remains, to encreaſe the ſquare of EO, if it be $-r$ in the equation; or, to diminiſh it, if it be $+r$, by the addition or ſubſtraction of the rectangle ar, from whence the ſquare of the radius of the circle ſought is compoſed: This is the method of inveſtigating *Baker*'s central rule, which is eaſy and free of all cautions, and the only difference ariſes hence, that Mr. *Hailey* determines the centre of the circle by the axis, and Mr. *Baker* by a parallel to the axis; and that the former hath always four affirmative roots on the right ſide of the axis, which the latter has ſometimes on the right and ſometimes on the left.

As to cubic equations, they are to be reduced to biquadratics, before they can be conſtructed by the ſame general rule; which is done by multiplying the equation propoſed by its root z, whence ariſes a biquadratic equation, in which the laſt term or r is wanting; wherefore taking away the ſecond term, and finding the centre E, the line EO is the radius of the circle; *viz.* when $ar = 0$; and the whole fifth term, in the new equation, ariſes from the taking away of the ſecond term.

Example, $z^3 - bzz + apz + aaq = 0$, which, multiplied into z, becomes $z^4 - bzzz + apz^2 + aazq = 0$; to take away the ſecond term, let $x + \frac{1}{4}b = z$ and it will be,

$$\begin{array}{l} x^4 + bx^3 + \frac{3}{8}bbxx + \frac{1}{19}b^3x + \frac{1}{256}b^4 = +z^4. \\ \quad - bx^3 - \frac{3}{4}bbxx + \frac{1}{16}b^3x - \frac{1}{64}b^4 = -bz^3. \\ \qquad\qquad + apxx + \frac{1}{2}apbx + \frac{1}{16}apbb = +apzz. \\ \qquad\qquad\qquad\qquad + aaqx + \frac{1}{4}aaqb = +aaqz. \end{array}$$

In this new equation, the half coefficient of the third term divided by a, *viz.* $-\frac{3bb}{16a} + \frac{1}{2}p$ is to be ſubſtituted for $\frac{1}{2}p$; and the half coefficient of the fourth term divided by aa, the ſquare of the *Latus Rectum*, *viz.* $-\frac{b^3}{16aa} + \frac{pb}{4a} + \frac{1}{2}q$ is inſtead of $\frac{1}{2}q$ in *Cartes*'s conſtruction, from whence the centre E is determined; then drawing a parallel to the axis, at the diſtance $\frac{1}{4}b$ to the left ſide, becauſe $x + \frac{1}{4}b = z$, whoſe interſection with the parabola, let be O; a circle deſcribed from the centre E and with the radius EO will either cut or touch the parabola, in as many points as the equation hath true roots; which roots, or z are perpendiculars let fall from thoſe points upon the parallel to the axis, the affirmative on the right ſide, and the negative on the left: If the third or fourth term, or both, be wanting in the equation, in inveſtigating the central rule, there is no manner of difference at all to be obſerved; but the quantity p or q being wanting, thoſe parts of the lines C D and D E, in ſome meaſure deduced from that quantity, will be wanting too; and we are to proceed with the remaining co-efficients of the third and fourth terms in the new equation, according to the method preſcribed in the preceeding examples.

Hitherto Mr. *Baker*'s general method hath been conſidered, than which none more eaſy and expeditious can be expected, aſſuming for the conſtruction either a parabola, or any other curve, *viz.* when the equation riſes to a biquadratic: But while Mr. *Halley* was writing theſe things, he hit upon a geometrical effection of the central rule, which is expeditious beyond what can be hoped for, and will ſufficiently ſatisfy the curious in thoſe matters: Having deſcribed the parabola N A M, Fig. 8. Plate XII. whoſe vertex is A, axis A B C and parameter a, let the equation be reduced to this form $z^4 . bz^3 . apzz . aaqz . ar . = 0$; or to this, if it be only a cubic, $z^3 . bz^2 . apz . aaq . = 0$; then at the diſtance $BD = \frac{1}{4}b$ let the line D H, meeting the parabola in D, be drawn parallel to the axis, to the left, if it be $-b$, and to the right, if $+b$, and from D let fall the perpendicular B D to the axis; in the line A B produced towards B, make $BK = \frac{1}{2}a$, and draw the indefinite line D K; further let K C be = to 2 A B, always in the axis produced beyond K; and if the quantity p have the ſign $-$, take towards the ſame part $CE = \frac{1}{2}p$, or towards the contrary part, if it be $+p$, and from the point E let the perpendicular E F be erected to the axis, (or from the point C, if the quantity p be wanting) meeting the line D K in the point F produced if needful, which is the centre of the circle ſought, if the quantity q be wanting; but if q be in the equation, then take, in the line F E produced, if need be, the line $FG = \frac{1}{2}q$, to the left hand, if it be $+q$, but to the right, if $-q$; and the point G will be the centre of the circle proper for the conſtruction, and its radius, if the quantity r be wanting, that is, if it be only a cubic equation, will be the line G D; the ſquare of which, in biquadratic equations, is to be augmented by the addition of the rectangle under r, and the *Latus Rectum*, if it be $-r$; or to be diminiſhed by the ſame rectangle, if it be $+r$: The circle being thus deſcribed, and perpendiculars being let fall on the line D H from its interſections with the parabola; thoſe on the left, as N O, always denote the nega-

tive

tive roots of the equation, and thoſe on the right, the affirmative.

Cubic equations are otherwiſe, and ſomething more ſimply, conſtructed according to *Schooten*'s rule, in which alſo the roots are referred to the axis; but becauſe the author himſelf does neither explain the method of inveſtigation nor the demonſtration, it will not be improper in this place to ſhew the foundation thereof, and at the ſame time render the geometrical conſtruction more elegant, and clear it of thoſe cautions, wherein it is involved: This rule is derived hence, that all cubic equations may be reduced to biquadratics, in which the ſecond term is wanting; and this is done, by multiplying the propoſed equation into $z - b = 0$, if it be $+ b$ in the equation; or into $z + b = 0$, if it be $- b$; and the new equation, thus produced, will have the ſame roots with the cubic; and beſides, another $=$ to $- b$, if it be $- b$ in the equation; or contrariwiſe: Let the equation, $z^3 - bz^2 + apz + aaq = 0$, be propoſed to be conſtructed; this, multiplied into $z + b$, becomes,

$$\begin{aligned} z^4 - bz^3 &+ apz^2 + aaqz \\ + bz^3 &- bbzz + abpz + aaqb. \end{aligned}$$

Here now the ſecond term is wanting, and the co-efficient of the third term, $- bb + ap$, gives $- \frac{bb}{2a} + \frac{1}{2}p$, inſtead of $\frac{1}{2}p$ or CD in *Cartes*'s conſtruction; and from half the co-efficient of the fourth term is made $+ \frac{1}{2}q + \frac{1}{2}\frac{bp}{a}$ inſtead of $\frac{1}{2}q$ or DE, therefore the centre of the circle ſought is determined; and becauſe one of the roots of the new equation is given, *viz.* $+ b$, a point in the circumference will be alſo given, and conſequently its radius: Laſtly, having deſcribed the circle, perpendiculars let fall from its interſections with the parabola to the axis will give the roots of the equation, both affirmative and negative, in the ſame manner as above: Now the centre of the circle is inveſtigated by a very eaſy conſtruction, which is to be preferred to all others in cubics: Let A, Fig. 9. Plate XII. be the vertex, and AF the axis of the deſcribed parabola AMD; at a diſtance equal to b, let DK be drawn parallel to the axis, to the right hand, if it be $+ b$ in the equation; and to the left, if it be $- b$, which may meet the parabola in the point D; on the centres D and A with equal radii deſcribe on both ſides two faint arches, interſecting each other, and thro' the points of interſection draw the indefinite

finite line B C, a perpendicular to the middle of the line A D, and which may meet the axis in the point E; from E ſet off $EF = \frac{1}{2}p$ downwards, if it be $-p$ in the equation, but upwards towards A, if it be $+p$; and from F (or E if p be wanting) erect the perpendicular F G, meeting the line B C in G; and in G F produced, take $GH = \frac{1}{2}q$, to the right hand, if it be $-q$ in the equation; but to the left, if $+q$, and H will be the centre ſought, and H D the radius of the circle, which, letting fall perpendiculars upon the axis from its interſections with the parabola, will ſhew all the roots, as L M, of the equation.

An invariable Compaſs; *by* M. de la Hire. Phil. Tranſ. N° 188. p. 344.

M. *De la Hire*, having determined, as well as he could, the ſouth pole of a *Terrella*, or ſpherical loadſtone, of three inches diameter, was very much ſurpriſed to find it 18° diſtant from a croſs, deeply engraven on a ſtone, which, probably, had formerly been the pole of this ſtone; as it had been obſerved by him that cut it; this change having revived ſome thoughts he had formerly entertained concerning the variation of the needle, he believed that if it were true, that the poles of the magnetical virtue were changed in the loadſtone, as is ſeen that they are changed in the earth, one might derive great advantages therefrom; for if this change of theſe poles in the loadſtone were certain, and that it was analogous to the change of the poles of the magnetic virtue in the earth, it is not to be doubted but a *Terrella*, ſuſpended freely, would remain immoveable, and that one point thereof would regard the pole of the world, which might be called the true pole of the ſtone, whilſt the poles of its virtue would paſs ſucceſſively from one part to another, after the ſame manner as they change on the earth: After having well conſidered this hypotheſis, and cleared up ſome doubts, which he had concerning the poſition of the ſtone, at the time when its pole had formerly been determined, he concluded that this former pole was diſtant from the point, he calls the true pole, 13° towards the eaſt, in the place where it had been marked, and ſince that, the needle varied about 5° weſtwards: Upon this hypotheſis, M. *de la Hire* invented a new ſort of needle for the compaſs, which might have the ſame alterations as a ſpherical loadſtone, and at the ſame time the ſame conveniencies as the other needle hath: He cauſed a ring of three inches diameter to be made of ſteel-wire, from which there run three radii of very fine braſs-wire meeting at the centre in a caſe exactly like that of an ordinary compaſs, that ſo this circle might reſt on a pin in its centre, and be at full liberty to turn round, whilſt its centre was fixed; this done, he gave the magnetical touch to this ſteel ring, by applying, indifferently, to a point thereof, one of the poles of a ſtrong loadſtone, and the other pole of the ſtone to the oppoſite point, to give the greater virtue to the ring; then he obſerved, that the ring was ſtrongly magnetical, and that the point, called the ſouth pole, did really turn itſelf towards the north, and after ſeveral vibrations ſtop there; and that it had alſo the ſame inclination towards the pole, which is found in needles after they have been touched; laſtly, he fixed upon the ring a ſmall *Flour de lis* of braſs, in the north point, after having firſt well ſettled the ring: In order to diſcover, whether a ſteel ring had the ſame effect as a *Terrella*, he made the following experiment; having touched a ſteel ring, and laid it on paper, he ſtrewed the filings of ſteel upon it, and then gently ſhaking the paper, he obſerved, that the direction of the magnetical matter paſſed directly croſs the ring from one pole to the other, and that there were two *Vortices* on the ſides, as is obſerved in the *Terrella*, which ſeems very ſurpriſing; for according to the common hypotheſis of the magnet, the magnetical virtue, paſſing more eaſily in the ſteel than in the air, ſhould run on both ſides of the pole round the ring, and only form a pole oppoſite to the firſt; but he was further confirmed in this opinion, by applying a flat and pointed piece of iron, like the blade of a knife to a loadſtone, ſo as that the point of the iron reached beyond the ſtone; and having afterwards preſented this point to the magnetical ring, he obſerved, that different points of the ring did apply themſelves to the point of the iron, according as the ſeveral points thereof had been applied to the ſtone, which happens not in the magnetical needle; for that always preſents one of its ends to the point of the iron, being not diſpoſed, by reaſon of its length, to receive the magnetical effluvia in all the parts thereof, analogous to thoſe of the ſtone: It muſt only be noted, that in an irregular ſtone, the magnetical virtue appears ſtronger towards the angles than in the other parts, which may cauſe ſome irregularity in this experiment, if it be tried with a ſtone that is very uneven: Theſe experiments gave the hint of making another, by touching two ſemicircles of ſteel; having joined the two ends, touched by the ſame poles, he obſerved by the ſteel duſt the ſame effect as in the ring; but having joined the ends, differently touched, he found, that immediately the two half rings run together, and ſtuck to each other; and by the ſteel duſt ſtrewed on paper, he obſerved, that there were four *Vortices*, one in the middle of each ſemicircle, and one at each of the places, where they were joined, and that the two latter were leſs than the others, and much ſtronger; he likewiſe obſerved, that there were four poles, each of which was within a *Vortex*, and that each retained in its ſemicircle the virtue of the ends of the half rings: He attempted to make a ring of a ſtreight ſteel wire, after having touched it; but he found, that it had quite loſt its virtue, which cannot be attributed to the joining of the poles, ſince they ought to cohere together, according to the other experiments which have been made, but only to this, that it hath been already noted, that when a magnetical *Virgula* is a little bent, it loſes its virtue, which cannot happen, but from the alteration of the pores of the ſteel: He further remarked, that a ring of ſteel, having been touched, does for a long time retain its virtue, altho' it be put in a poſition contrary to its poles; and this experiment is confirmed by another much more conſiderable, which is, that a ring of ſteel, being touched with a ſtrong loadſtone, cannot without difficulty receive a contrary touch from a magnet, weaker than the firſt; but that in time, by little and little, it reſumes its former virtue; juſt as we ſee magnets do, which, being applied to another ſtone, by the poles of the ſame denomination, loſe their firſt virtue, and aſſume a contrary, which they afterwards loſe by degrees, to re-aſſume their former: After M. *de la Hire* had preſented this new ſyſtem to the academy, ſome experiments were made upon a *Terrella* of much the ſame diameter with his, but whoſe poles were not diametrically oppoſite; and upon a half globe, much bigger than the *Terrella*; but there was no conſiderable difference or alteration of poles obſerved.

The circular needles may be touched a-new, in this manner; apply the poles of the ſtone to the ring, and the ring, which is ſuſpended upon its pivot, will turn in ſuch a manner, as that the point anſwering to the virtual pole of the ſtone, which is applied to it, will come as near it as poſſible; inſomuch, that without touching each other, the ring will not fail to receive a ſtrong magnetical attraction; the ſame may be done at the oppoſite point.

This account having been read before the Royal Society, it was ordered, that the *Terrella*, in their repoſitory, ſhould be examined; and it was found, that the points, marked thereon with croſſes, were, as near as could be diſcerned, the true poles of the ſtone, notwithſtanding that the variation had changed at *London* full 4° ſince the *Terrella* had been in the Society's cuſtody; and had there been a change in the poles of the loadſtone analogous thereto, it muſt needs have been perceived in this, whoſe diameter is about 4 ½ inches: However, to put this matter out of diſpute, care was taken to find out exactly, and mark the poles of the Society's great loadſtone, the ſphere of whoſe activity is above 9 foot radius, and whoſe poles are 13 inches aſunder; whereby, if this tranſlation of the poles be real, it cannot fail of being made very ſenſible hereafter: In the mean time, ſome of the company, well ſkilled in magnetics, were of opinion, that ſuch a circular needle would librate on its centre, ſo as to reſpect the magnetical meridian, with the points that had at firſt received the touch, rather than that the ring, remaining immoveable, the directive virtue ſhould be transferred therein from place to place, either by length of time, or by tranſporting this compaſs into thoſe parts, where the variation of the needle is conſiderably different.

Of a burning Concave *in* Germany. Phil. Tranſ. N° 188. p. 352.

THE outer circle of this concave burning *Speculum*, which was made at *Luſace*, was nearly 3 *Leipſic* ells in diameter, exceeding the great one at *Paris* by ¼ of ſuch an ell; it was made of a copper plate, ſcarce twice as thick as the back of an ordinary knife: The force of this *Speculum* was incredible; for, 1. A piece of wood put into the *Focus* (which was 2 ells off) flamed in a moment, ſo that a freſh wind could hardly put it out. 2. Water, applied in an earthen veſſel, preſently boiled; and the veſſel held there for ſome time, the water evaporated all away. 3. A piece of tin, or lead, 3 inches thick, as ſoon as it was put into the *Focus*, melted away in drops; and held there a little time, was in a perfect fluor, ſo as in 2 or 3 minutes to be quite pierced thro'. 4. A plate of iron, or ſteel, placed in the *Focus*, was immediately ſeen to be red hot on the back-ſide, and ſoon after a hole was burnt thro'. 5. Copper, ſilver, and the like, applied to the *Focus*, were melted, and which was tried with ſeveral ſorts of coin, amongſt the reſt, with a *Rix-dollar*; and the ſame thing happened to it in 5 or 6 minutes, as to the aforeſaid iron plate.

6. Things not apt to melt, as ſtones, brick, and the like, ſoon became red hot like iron. 7. Slate at firſt became red hot, and in a few minutes was turned into a fine ſort of black glaſs, which, taken in the tongs, and drawn out, would run into glaſs threads. 8. Tiles, which had undergone the intenſeſt degree of heat, were in a little time melted down into a yellow glaſs. 9. Potſherds, not only well burnt at firſt, but much uſed in the fire, were turned into a blackiſh yellow glaſs. 10. Pumice-ſtone was melted into a white tranſparent glaſs. 11. A piece of a very ſtrong crucible, put into the *Focus*, in 8 minutes, was melted down into glaſs. 12. Bones were turned into a kind of opake glaſs, and a clod of earth into a yellow or greeniſh glaſs: Theſe experiments were made in *Auguſt* and *September*, when the ſun had not the ſame force, as when he is about the ſummer ſolſtice: The rays of the full moon concentred by this *Speculum*, did not produce any degree of heat, tho' the light was not a little encreaſed.

Dr. *Hook* was of opinion, that a *Speculum* might be made of ſeveral feet in diameter; for a ſmall piece, being hammered out of a copper plate, and tinned over with a mixture of tin, lead, and tin-glaſs, which is found to bear a very good poliſh: Such a *Speculum* might be of great uſe in perfecting the art of paſtes, or factitious jewels, which require the intenſeſt degree of heat, to bring them to an exact mixture.

An Eſtimate of the Quantity *of* Vapours *raiſed by the* Sun; *by Mr.* Edm. Halley. Phil. Tranſ. N° 189. p. 366.

WE took a pan of water (ſalted to the ſame degree with common ſea-water, by the ſolution of about a fortieth part of ſalt) about 4 inches deep, and 7 $\frac{2}{10}$ inches in diameter, in which was placed a thermometer; and by means of a pan of coals, the water was brought to the ſame degree of heat with that of the air in our hotteſt ſummers, which was nicely ſhewn by the thermometer: This done, the pan of water, with the thermometer in it, was affixed to one end of the beam of the ſcales, and exactly counterpoiſed; and by the application or removal of the pan of coals, it was found very eaſy to keep the water in the ſame degree of heat preciſely; and proceeding thus, the weight of the water was obſerved ſenſibly to decreaſe; and at the end of two hours, there wanted $\frac{1}{2}$ an ounce *Troy*, all but 7 grains, or 233 grains of water, which, in that time, had gone off in vapour; tho' one could hardly perceive it ſmoke, and the water was not ſenſibly warm: This quantity in ſo ſhort a time ſeemed very conſiderable, being little leſs than 6 ounces in 24 hours, from ſo ſmall a ſurface as a circle of 8 inches diameter: To reduce this experiment to an exact *Calculus*, and determine the thickneſs of the film of water, that had ſo evaporated, Mr. *Halley* aſſumed the experiment alledged by Dr. *Edw. Bernard*, to have been made in the *Oxford* Society; *viz.* that the cubic foot *Engliſh* of water, weighs exactly 76 pounds *Troy*; this, divided by 1728, the number of inches in a foot, will give $253\frac{1}{3}$ grains, or $\frac{1}{2}$ an ounce $13\frac{1}{3}$ grains for the weight of a cubic inch of water; wherefore, the weight of 233 grains is $\frac{233}{253}$, or, 35 parts of 38 of a cubic inch of water: Now the area of the circle, whoſe diameter is $7\frac{9}{10}$ inches, is 49 ſquare inches; by which, dividing the quantity of water evaporated, *viz.* $\frac{35}{38}$ of an inch, the quotient $\frac{35}{1862}$, or $\frac{1}{53}$, ſhews that the thickneſs of the water evaporated was the 53d part of an inch; but we will ſuppoſe it only the 60th part for the facility of calculation; if therefore water, as warm as the air in ſummer, exhales the thickneſs of a 60th part of an inch, from its ſurface, in two hours; in 12 hours, it will exhale $\frac{1}{10}$ of an inch; which quantity will be found abundantly ſufficient to ſerve for all the rains, ſprings, and dews; and account for the *Caſpian Sea*'s being always at a ſtand, neither waſting nor overflowing; as likewiſe for the current ſaid to ſet always in, at the ſtreights of *Gibraltar*, tho' theſe *Mediterranean* ſeas receive ſo many, and ſo conſiderable rivers.

In order to eſtimate the quantity of water riſing in vapours out of the ſea, we ought to conſider it only for the time the ſun is up; becauſe the dews returning in the night as much, if not more vapours than are then emitted; and in ſummer, the days being longer than 12 hours, this exceſs is balanced by the weaker action of the ſun, eſpecially when riſing before the water is warmed; ſo that it may not be an improbable conjecture, if we allow $\frac{1}{10}$ of an inch of the ſurface of the ſea to be raiſed in a day by vapours: Upon this ſuppoſition, every 10 ſquare inches of the ſurface of the water yield, in vapours a day, a cubic inch of water; and each ſquare foot, $\frac{1}{2}$ a wine pint; every ſpace of 4 foot ſquare, a gallon; a mile ſquare, 6914 tons; a ſquare degree, ſuppoſe of 69 *Engliſh* miles, will evaporate 33 millions of tons; and if the *Mediterranean* be eſtimated at 40 degrees long, and 4 broad, allowances being made for the places, where it is broader, by thoſe where it is narrower, there will be 160 ſquare degrees of water; and conſequently the whole *Mediterranean* muſt loſe in vapour in a ſummer's day, at leaſt 5280 millions of tons; and this quantity of vapour, tho' very great, is as little as can be concluded from the experiment produced; and yet there remains another cauſe, which cannot be reduced to the rule, *viz.* the winds, whereby the ſurface of the water is exhaled ſomewhat faſter than it can be by the heat of the ſun; as is well known to thoſe who have conſidered thoſe drying winds which ſometimes blow.

The *Mediterranean* receives theſe conſiderable rivers; *viz.* the *Iberus*, *Rhone*, *Tiber*, *Po*, *Danube*, *Nieſter*, *Boryſthenes*, the *Tanais* and the *Nile*, all the reſt being of no great note, and their quantity of water inconſiderable: Let us ſuppoſe each of theſe nine rivers to bring down ten times as much water as the *Thames*: To calculate the water of the *Thames*, Mr. *Halley* aſſumes that at *Kingſton* bridge, where the flood never reaches, and the water always runs down; the breadth of the channel is 100 yards, and its depth three; hence the profile of the water in this place is 300 ſquare yards; this multiplied by 48 miles, (which the water is ſuppoſed to run in 24 hours, at the rate of two miles an hour) or 84480 yards, gives 25344000 cubic yards of water to be diſcharged every day, that is, 20300000 tons a day: Now, if each of the aforeſaid nine rivers yield ten times as much water as the *Thames* doth, it will follow, that each of them yields but 203 millions of tons a day, and the whole nine, but 1827 millions of tons in a day; which is but little more than $\frac{1}{3}$ of what is proved to be raiſed in vapour out of the *Mediterranean* in twelve hours time.

Of the Number of Roots *in* Cubic *and* Biquadratic Equations, *with their* Limits *and* Signs; *by Mr.* Edm. Halley. Phil. Tranſ. N° 190. p. 387. *Tranſlated from the* Latin.

IT is plain, that both in cubic and biquadratic equations, the roots may be expounded by perpendiculars let fall upon the axis, or given diameter of the given parabola, from the interſections of that curve with the circle; and ſince a circle, cutting a parabola, muſt neceſſarily interſect it either in four, or in two points, it is manifeſt, that in biquadratics there always are, either two or four true roots, affirmative or negative; as alſo, if the circle happen to touch it, in which caſe, the equality of two roots of the ſame ſign is concluded: But in cubic equations, becauſe one of the interſections is required for the conſtruction, therefore either only one, or the three remaining roots denote one or three, as in the caſe of contact; whence it appears, that there are found two equal roots, and that the problem, from whence the equation reſults, is really plane: Therefore, all cubic equations, however adfected, are explicable either by one, or by three roots, and which are always poſſible, if we admit negative roots for true ones: So biquadratics, whoſe laſt term r is affected with the ſign —, are explicable by two or four; but if it be $+ r$ in the equation, and it be ſo great, that $\sqrt{GD^2 - ar}$, Fig. 8. Plate XII. be leſs than that the circle deſcribed with that radius, and on the centre G, can touch the parabola in any point; the given equation is altogether impoſſible, nor is it explicable by any affirmative or negative root; but of this, more hereafter.

Now, ſince there is ſo great a difference between the caſes of cubic and biquadratic equations, that they cannot be compriſed together; we ſhall firſt treat of cubics, and then of the others: Cubic equations are conſtructed by an infinite number of circles in a given parabola; but biquadratics, by one only, at leaſt, by theſe methods; and that becauſe, putting $z - e$, or any other indeterminate equal to nothing, a cubic equation is reduced to a biquadratic, having the ſame roots with the cubic; and beſides, another equal to e; whence it is, that a cubic equation may be conſtructed by as many different circles, as you can imagine quantities, e, that is an infinite number; and of all theſe conſtructions, the eaſieſt is that which Mr. *Halley* gave towards the end of his preceeding diſcourſe on the conſtruction of cubic and biquadratic equations; yet the following is nothing inferior thereto, which ſeems better accommodated to the deſign of determining the number of roots and their limits, and which ariſes from the taking away of the ſecond term, by putting after the common manner, $x = z +$, or, $-\frac{1}{3}$ of the co-efficient of the ſecond term; and it is this: The parabola A B Y, Fig. 10. being given, whoſe vertex is A, axis A E, and *Latus Rectum a*, reduce the equation to the uſual form, *viz.* $z^3.\ bz^2.\ apz.\ aaq. = 0$; then at the diſtance of $\frac{1}{3} b$, let B K be drawn parallel to the axis, to the right hand, if it be $+ b$; otherwiſe to the left, meeting the parabola in B; and let the indefinite line D P be raiſed perpendicular to the ſuppoſed line A B, meeting the axis in G; from the point B, let fall upon the axis the perpendicular B C, and let G E be always = to A C, and be ſet off towards the inferior parts; from E, ſet off E H $= \frac{1}{2} p$; upwards, if it be $+ p$ in the equation; but downwards, if $- p$; and from the point H (or E, if the quantity p be wanting) let the perpendicular H Q be produced meeting the indefinite line D P in the point O; laſtly, in the indefinite line H Q, let O R be $= \frac{1}{2} q$, to be ſet off from O to the right hand, if it be $- q$, but to the left, if $+ q$; and a circle, deſcribed from the centre R, and with the radius R A, will cut the parabola in ſo many points, as the propoſed equation hath true roots; and they will be the perpendiculars Z Y let fall from the interſections Y to the line B K parallel to the axis; of which thoſe, to the right hand of the line B K, are affirmative, and thoſe to the left, negative: The advantage of this conſtruction conſiſts in this, that it is performed by a circle paſſing thro' the vertex, in the ſame manner, as if the ſecond term were wanting; and therefore to determine the number of roots, it is ſufficient to know the properties of the *Locus* or curve, which diſtinguiſhes the ſpaces, wherein, if the centre of the circle, which paſſes thro' the vertex of the parabola, be placed, its circumference will interſect the parabola, either in one or three other points; that is, to define the nature of that curve, on which the centres of all the circles paſſing thro' the vertex and then touching the parabola do fall: Now that *Locus* is the paraboloid, which, with Dr. *Wallis* we may call the ſemicubical, or in which, the cubes of the ordinates are as the ſquares of the correſponding abſciſſes; whoſe *Latus Rectum* is $\frac{22}{8}$ of the *Latus Rectum* of the given parabola, and its vertex the point U the line A U being half the *Latus Rectum* of the ſame parabola; that is, if we put unity for the *Latus Rectum* of the given parabola, then $\frac{4}{27}$ of the cube of the ordinate will be equal to the ſquare of the abſciſs; or the cube of $\frac{2}{3}$ U H = the ſquare of H R, *viz.* if R be the centre of the circle that paſſes thro' the vertex of the parabola, and touches the ſame afterwards: This is that curve, which our countryman Mr. *Neil* firſt of all demonſtrated to be equal to a given right line; this curve deſcribed on both ſides of the axis of the parabola, as U N L, U P X, comprehends a ſpace, in which, if the centre of the circle, which paſſes thro' the vertex A, be placed, it will cut the parabola in three other points; but the ſpaces, more remote from the axis, afford centres for circles, that will cut the parabola but in one point beſides the vertex.

Theſe things being well underſtood, we ſhall now proceed to determine the number of the roots; and firſt of all, let the ſecond term be wanting, and let the *Latus Rectum* be 1, or A U $= \frac{1}{2}$; in the conſtruction U H is $= \frac{1}{2} p$, H R $= \frac{1}{2} q$; and ſince, if it be $+ p$ in the equation, $\frac{1}{2} p$ is to be ſet off from

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from U towards the upper parts, the centre of the circle is always without the ſpace L U X, and therefore explicable by one only root, which is affirmative, if it be $-q$, negative, if $+q$; which roots are inveſtigated by *Cardan*'s rule; but if it be $-p$, then U H $= \frac{1}{2}p$ is ſet off towards the lower parts; and it is poſſible that H R may fall between the axis and the curve U X or U L; *viz.* if the cube of $\frac{2}{3}$ U H, or of $\frac{1}{3}p$ be greater than the ſquare of $\frac{1}{2}q$; or $\frac{1}{27}p^3$ be greater than $\frac{1}{4}qq$; in which caſe there are three roots, two negative, if it be $-q$, and one affirmative equal to the ſum of the others; but if it be $+q$, then there are two affirmative and one negative root; but if $\frac{1}{27}ppp$ be leſs than $\frac{1}{4}qq$, then there is but one root, affirmative, if it be $-q$, negative if $+q$: Now let all the terms be compleat, and firſt let there be propoſed as an example, this equation, $z^3 - bz^2 + pz - q = 0$, for which Fig. 10. ſerves; in the conſtruction of this, B C $= \frac{1}{3}b$, U G $= \frac{1}{2}$ A C $= \frac{1}{18}bb$, U E $= \frac{1}{6}b^2$, U H $= \frac{1}{6}bb - \frac{1}{2}p$, G H $= \frac{1}{9}bb - \frac{1}{2}p$, or $\frac{1}{2}p - \frac{1}{9}bb$; hence H O $= \frac{1}{27}b^3 - \frac{1}{6}bp$, or $\frac{1}{6}bp - \frac{1}{27}b^3$, and H R, or the diſtance of the centre R of the circle from the axis, is always the difference of $\frac{1}{6}bp$ and $\frac{1}{27}b^3 + \frac{1}{2}q$; which if they are equal, then the centre falls in the axis; if $\frac{1}{6}bp$ be greater than $\frac{1}{27}b_3 + \frac{1}{2}q$, then it falls on the left of the axis, if leſs, on the right: If therefore the ſquare root or $\sqrt{ddd}$ of the cube of $\frac{2}{3}$ U H, that is, of $\frac{1}{9}bb - \frac{1}{3}p$, noting it d, be greater than H R, that is, the difference between $\frac{1}{27}b^3 + \frac{1}{2}q$ and $\frac{1}{6}bp$; the centre R is found within the ſpace N P U, circumſcribed by the paraboloids U P X, U N L and the indefinite right line D N P; and therefore the circle will cut the parabola in three points Y, Y, Y, poſited on the right of the lines B K, and ſo the equation hath three affirmative roots; but the centre being without this ſpace M U P, it is explicable by one only affirmative root: Here we are to obſerve by the bye, that the right line D P touches the paraboloid U P X in the point P, E P being $\frac{1}{27}b^3$; but cuts the other paraboloid U N L in the point N; ſo that letting fall N F perpendicular to the axis, U F is $\frac{1}{4}$ of E U, or $\frac{1}{24}bb$, and N F of $\frac{1}{108}b^3$; but U W, which, from the point U being raiſed perpendicular to the axis, meets the line D P in W, is $= \frac{1}{54}b^3$ or $\frac{1}{2}$ E P: Hence we may ſafely conclude, that if in the equation, either p be greater than $\frac{1}{3}b^2$, or q be greater than $\frac{1}{27}b^3$, that there will be found but one root, and that an affirmative one; *Cartes*'s rule then, page 70. *Edit. Amſterd.* 1659, fails, in which he determines that there are always as many true roots, as there are changes of the ſigns + and — in the equation; tho' *Schooten* in his commentaries would excuſe this miſtake; for many more equations of the preceeding form with three changes of ſigns may be deviſed, which have rather one than three roots; alſo *Prop.* 5. *Sect.* 5. of our countryman *Harriot's Ars Analytica*, as alſo *Prob.* 18. of *Vieta's Numer. Poteſt. Reſol.* is hardly ſound; ſince from the limitations they have there ſet down, that muſt agree to the whole parallelogram PIUW, which we have juſt now proved to agree only to the ſpace NUP alone, that is, to afford a centre for the circle interſecting the parabola in three other points beſides the vertex; but the quantity q, or the laſt term (b and p given, ſo that p be leſs than $\frac{1}{3}b^2$) is accurately limited from the preceeding equation $\sqrt{ddd} = \overline{\frac{1}{27}b^3 + \frac{1}{2}q} \backsim \frac{1}{6}bp$; *viz.* when the circle touches the parabola; therefore $\frac{1}{2}q$ ſhould be leſs than $\frac{1}{6}bp - \frac{1}{27}b^3 + \sqrt{d^3}$; but if p be greater than $\frac{1}{4}bb$, alſo $\frac{1}{2}q$ ſhould be greater than $\frac{1}{6}bp - \frac{1}{27}b^3 - \sqrt{d^3}$, that the centre may not fall in the little ſpace NUW; and under theſe conditions the equation will always be explicable by three roots, otherwiſe but by one; but whether there be three or one, they are always affirmative, becauſe of the poſition of the centre R to the right hand of the line DP: And this is the moſt difficult caſe; ſo that ſuch, as underſtand what has been ſaid above will eaſily comprehend what follows: Now let the equation $z^3 - bz^2 + pz + q = 0$ be given; in this caſe, that there may be three roots had, the centre of the circle ſhould be found ſomewhere within the ſpace PN△ terminated by the right lines PN, P△, and the curve of the paraboloid N△; wherefore, ſince EF is $= \frac{1}{8}bb$, p ſhould be leſs than $\frac{1}{4}bb$; now to determine the quantity q, d being $= \frac{1}{9}b^2 - \frac{1}{3}p$ as before; $\sqrt{d^3} + \frac{1}{27}b^3 - \frac{1}{6}bp$ ſhould be always greater than $\frac{1}{2}q$, that ſo the centre of the circle may be poſited in the forementioned ſpace PN△; which when it is ſo, ſuch an equation hath two affirmative roots, and one negative; but if p be greater than $\frac{1}{3}bb$, or $\frac{1}{2}q$ greater than $\sqrt{d^3} + \frac{1}{27}b^3 - \frac{1}{6}bp$, it is explicable but by one, and that a negative root: Now let the equation $z^3 - bz^2 - pz - q = 0$ be propoſed; that this equation may have three roots, the centre of the circle muſt be found ſomewhere in the indefinite ſpace between the right line DPD and the curve of the paraboloid PX; the quantity p is not here liable to limitations; but $\frac{1}{2}q$ ſhould always be leſs than $\sqrt{d^3} - \frac{1}{27}b^3 - \frac{1}{6}bp$, ſuppoſing d to be $= \frac{1}{9}bb + \frac{1}{3}p$; by this means there are given two negative roots, and one affirmative; but otherwiſe, if $\frac{1}{2}q$ be greater than $\sqrt{d^3 - \frac{1}{27}b^3 - \frac{1}{6}bp}$, the equation is explicable by one only affirmative root: Fourthly, let the equation $z^3 - bz^2 - pz + q = 0$, be propoſed, which hath two affirmative roots and one negative, if the centre of the circle be found in the indefinite ſpace between the right lines P△, PD, and the curve of the paraboloid △L; that is, (putting $d = \frac{1}{9}bb + \frac{1}{3}p$) if $\frac{1}{2}q$ be leſs than $\sqrt{d^3 + \frac{1}{27}bbb + \frac{1}{6}bp}$; but if $\frac{1}{2}q$ be greater than this quantity, there is but one negative root: But the four remaining equations, in which we have $+b$, do not differ from theſe that have been mentioned already, as to the limitation of the number of the roots, if the ſign of the laſt term be changed, retaining the ſign of the third term; but then the roots that were affirmative in the former will be negative here, and contrariwiſe: Thus in the equation $z^3 - bz^2 + pz - q = 0$, the affirmative roots were either one or three; but in this equation $z^3 + bz^2 + pz + q = 0$, there is either one or three negative roots under the ſame conditions, but no affirmative root at all; ſo alſo in the equation $z^3 + bz^2 + pz - q = 0$, there are two negative and one affirmative root, if p be leſs than $\frac{1}{3}bb$, and $\frac{1}{2}q$ be leſs than $\sqrt{d^3 + \frac{1}{27}b^3 - \frac{1}{6}bp}$; juſt as in the equation $z^3 - bz^2 + pz + q = 0$, there were two affirmative and one negative root; but p and q exceeding thoſe preſcribed meaſures, there is only one affirmative root in this latter, which in the former was negative: After the ſame manner, in the equation $z^3 + bz^2 - pz + q = 0$, either there are two affirmative and one negative root, or one negative only: Laſtly, for the ſame reaſon in the equation $z^3 + bz^2 - pz - q = 0$, there are two negative and one affirmative root, or one affirmative only; for which, in the equation $z^3 - bz^2 - pz + b = 0$, there were two affirmative and one negative root, or one negative only; *viz.* as $\frac{1}{2}q$ is either greater or leſs leſs than $\sqrt{d^3 + \frac{1}{27}b^3 + \frac{1}{6}bp}$: If the third term, or pz, be wanting, the centre R does always fall in the line IPE△; wherefore, if it be $z^3 - bz^2 . * . - q$, or $z^3 + bz^2 . * . + q$, there can be but one root affirmative, if it be $-b$; negative, if $+b$; but if it be $z^3 - bz^2 . * . + q$, or $z^3 + bz^2 . * . - q$, there may be two affirmative and one negative root in the former, or one affirmative and two negatives in the latter, the centre falling in the line P△ between P and △, that is, if $\frac{1}{4}q$ be leſs than $\frac{1}{27}b^3$; for if it be greater, there can be but one negative root in the former, or one affirmative in the latter.

Hitherto we have fully attained to the number of roots in cubic equations, it remains that we add ſomething concerning the quantity of the roots; and here it is firſt of all to be noted, that every equation, having three roots, may be expeditiouſly reſolved by the help of the table of ſines; that is, by the triſſection of an angle; *viz.* by putting $\sqrt{\frac{4}{9}bb - \frac{4}{3}p}$, or $\sqrt{4d} =$ the radius of the circle, if it be $+ p$ in the equation, or $\sqrt{\frac{4}{9}b^2 + \frac{4}{3}p}$, if $- p$; and the angle to be triſſected, which may have its ſine in the table of ſines $\frac{\frac{1}{27}b^3 + \frac{1}{6}bp + \frac{1}{2}q}{\sqrt{d^3}}$; this angle being found, the ſine of its third part, as alſo the ſine of the third part of its complement to a ſemicircle, and their ſum will be given from the table of ſines: and theſe ſines are to be multiplied into the radius $\sqrt{\frac{4}{9}bb + \frac{4}{3}p}$, and thus will be obtained the quantities y, y, y, in the figure; the ſum, or difference, of which and $\frac{1}{3}b$, as the caſe requires, will give the true roots of the equation: All theſe things are deduced from *Cartes's* diſcoveries: But that all caſes may be comprehended with as much brevity as poſſible; the centre R, in the firſt formula of equations, falling in the ſpace U G P, the two interſections Y, Y, fall between A and B, and conſequently either of the leſſer roots is leſs than $\frac{1}{3}b$, but the third and greater always exceed $\frac{1}{3}b$, but are exceeded by b: But if the centre fall in the ſpace G N U, there are two greater than $\frac{1}{3}b$, but leſs than $\frac{2}{3}b$; but the third is $b -$ the two others, and conſequently leſs than $\frac{1}{3}b$; but uſing the limitation of the quantity p, the roots are included in narrower bounds; for the greateſt root is leſs than $\sqrt{\frac{4}{9}b^2 - \frac{3}{4}p} + \frac{1}{3}b$, but greater than $\sqrt{\frac{1}{4}bb - p} + \frac{1}{2}b$: but when $\frac{1}{4}bb$ is leſs than p, that limit becomes $\sqrt{\frac{1}{9}bb - \frac{1}{3}p} + \frac{1}{3}b$; the mean root is always leſs than $\sqrt{\frac{1}{4}b^2 - p} + \frac{1}{2}b$, but greater than $\frac{1}{3}b - \sqrt{\frac{1}{9}b^2 - \frac{1}{3}p}$; but the leaſt root never exceeds this limit, but vaniſhes with the quantity q.

In the ſecond formula, according to the preſcribed laws, there are two affirmative and one negative root; and the centre falling in the ſpace G P E, one of the affirmative is greater and the other leſs than $\frac{1}{3}b$, but the greater does not exceed b; the negative cannot be greater than $\sqrt{\frac{1}{3}bb - \frac{1}{3}b}$, and it is the difference of b and of the ſum of the affirmative roots: But the centre being poſited in the ſpace E N G Δ, either of the affirmative is greater than $\frac{1}{3}b$, but leſs than $\sqrt{\frac{1}{3}bb + \frac{1}{3}b}$; but the negative is always leſs than $\frac{1}{3}b$: But the nearer limits, from the quantity p being given, are $\sqrt{\frac{1}{4}bb-p}+\frac{1}{2}b$, of the greateſt affirmative root; than which it is always leſs, as alſo greater than $\sqrt{\frac{1}{9}bb-\frac{1}{3}p}+\frac{1}{3}b$; yet the other affirmative root, which, with the quantity q, is diminiſhed, is leſs than this limit; but the negative root is always leſs than $\sqrt{\frac{4}{9}bb+\frac{4}{3}p}-\frac{1}{3}b$, and it vaniſhes, when the quantity q is wanting.

In the third formula, there are two negative and one affirmative root; in this as in the fourth, the roots are not limited by the quantity b; but the affirmative root is ever leſs than $\sqrt{\frac{4}{9}bb+\frac{4}{3}p}+\frac{1}{3}b$, yet greater than $\sqrt{p+\frac{1}{4}bb}+\frac{1}{2}b$; and the greateſt of the negative is always greater than $\sqrt{\frac{1}{9}bb+\frac{1}{3}p}-\frac{1}{3}b$, but leſs than $\sqrt{p+\frac{1}{4}bb}-\frac{1}{2}b$; but the leſſer of the negative is always leſſened with the diminiſhed quantity q.

In the fourth formula, the centre falling within the ſpace L△PD; if there be two affirmative and one negative root, the greateſt of the affirmative cannot be greater than $\sqrt{p+\frac{1}{4}bb}+\frac{1}{2}b$, nor leſs than $\sqrt{\frac{1}{9}bb+\frac{4}{3}p}+\frac{1}{3}b$; but the leſſer root is diminiſhed by theſe limits, the quantity q being decreaſed: And the negative root is leſs than $\sqrt{\frac{4}{9}bb+\frac{4}{3}p}-\frac{1}{3}b$, and greater than $\sqrt{p+\frac{1}{4}bb}-\frac{1}{2}b$: But here it is to be noted, that the negative roots are every where marked with the affirmative ſign, becauſe theſe are the affirmative roots of thoſe four equations, wherein $+b$ is found, and q affected with the contrary ſign, as was hinted above: The demonſtration of all this follows from hence, that wherever the centre R of the circle falls on the curves VPX or V△L, its circumference touches the parabola in a point, whoſe diſtance from the axis is $\sqrt{\frac{2}{3}}$ VH, and cuts it on the other ſide of the axis at the diſtance of $2\sqrt{\frac{2}{3}}$ VH; but when the centre falls on the line DPD, one of the roots is $=0$, and conſequently the cubic equation is reduced to a quadratic, or to $z^2-bz+p=0$, whoſe roots give the limits, where the quantity q vaniſhes; and by how much the leſs q becomes, by ſo much the nearer the roots approach to thoſe limits: The equation is alſo a quadratic, when the centre falls in the axis; that is, when $\frac{1}{2}q=\frac{1}{6}bp-\frac{1}{27}b^3$ in the firſt formula or $\frac{1}{2}q=\frac{1}{27}bbb-\frac{1}{6}bp$ in the ſecond; in the third it is impoſſible; but in the fourth, when $\frac{1}{2}q=\frac{1}{27}bbb+\frac{1}{6}bp$; in which caſe, the leſſer of the affirmative roots is $\frac{1}{3}b$, and the greater $\sqrt{\frac{1}{3}bb+p}+\frac{1}{3}b$; but the negative $\sqrt{\frac{1}{3}bb+p}-\frac{1}{3}b$: In the firſt formula, the roots are $\frac{1}{3}b$, and $\frac{1}{3}b \pm \sqrt{\frac{1}{3}bb - p}$; but in the ſecond, $\frac{1}{3}b$ and $\sqrt{\frac{1}{3}\overline{bb - p}} + \frac{1}{3}b$ are affirmative, but $\sqrt{\frac{1}{3}bb - p} - \frac{1}{3}b$ is negative: And this may ſeem ſufficient for cubic equations; but becauſe of the excellent uſe of the method, in which, by means of table of ſines, the roots of theſe equations are found; it was thought proper to add an example or two, by which the compendium of that practice may appear: Let the equation, $z^3 - 39z^2 + 479z - 1881 = 0$, be propoſed, and the roots z are ſought; $\sqrt{\frac{1}{9}bb - \frac{1}{3}p} = \sqrt{9\frac{1}{3}} = \sqrt{d}$, whoſe double $\sqrt{37\frac{1}{3}}$ is the radius of the circle and $\frac{\frac{1}{27}b^3 + \frac{1}{2}q - \frac{1}{6}bp}{\sqrt{d^3}}$ $= \frac{2197 + 940\frac{1}{2} - 3113\frac{1}{2}}{9\frac{1}{3}\sqrt{9\frac{1}{3}}}$, or $\frac{24}{9\frac{1}{3}\sqrt{9\frac{1}{3}}}$ is the *Tabular Sine* of the angle, that is, making a diviſion by means of the logarithms, Log. 9.9251560, to which anſwers an angle of 57° 19′ 11½″; the third part of this is, 19° 6′ 24″; and of the complement, 40° 53′ 36″; the ſines give the logarithms 9.514983, and 9.816311, which multiplied into the radius $\sqrt{37\frac{1}{3}}$ produce Y & and Y &, log. 0.301030 = 2, and log. 0.601059 = 4, but the third Y & is equal to their ſum, or 6; and therefore the roots are $13 - 4 = 9$, $13 - 2 = 11$, and $13 + 6 = 19$, of which ſeveral quantities the abovementioned is compoſed; where it is to be obſerved, that the two leſſer roots do not exceed $\frac{1}{3}b$ or 13, becauſe the centre R in the conſtruction falls on the right hand of the axis; that is, $\frac{1}{6}b.p$ is leſs than $\frac{1}{27}b^3 + \frac{1}{2}q$.

For another example, let $x^3 - 15x^2 - 229x - 525 = 0$ be an equation, whoſe roots are ſought; here $\sqrt{\frac{1}{9}b^2 + \frac{1}{3}p} = \sqrt{101\frac{1}{3}} = \sqrt{d}$, and the radius of the circle $= \sqrt{405\frac{1}{3}}$; alſo $\frac{\frac{1}{27}b^3 + \frac{1}{6}bp + \frac{1}{2}q}{\sqrt{d^3}} = \frac{125 + 572\frac{1}{2} + 262\frac{1}{2}}{101\frac{1}{3}\sqrt{101\frac{1}{3}}} = \frac{960}{101\frac{1}{3}\sqrt{101\frac{1}{3}}}$ = the tabular ſine of the arch, whoſe Log. is 9.9736426, and the arch itſelf 70° 14′ 22″; the third part of it, is 23° 24′ 47″ ½, and of the complement, is 36° 35′ 12″ ½, whoſe Log. ſines are 9.599183, and 9.775275, to which adding the Log. of $\sqrt{405\frac{1}{3}}$ we have the Log. 0.903089 = 8, and Log. 1.079181 = 12, whoſe ſum is = 20: Hence we conclude that $20 + \frac{1}{3}b$ or 25 is equal to the affirmative root, and 8 and $12 - \frac{1}{3}b$, that is 8 and 7, are equal to the negative roots; but if the equation had been $x^3 + 15x^2 - 229x + 525 = 0$, then 8 and 7 had been the affirmative roots, and 25 the negative: As for the other cubic equations, which are explicable by one root only, they are to be reſolved by *Cardan*'s rules, after the ſecond term is taken away, nor can the thing be done with leſs calculation; but if this root be deſired to be expreſſed by the quantities b, p, q; in the firſt formula it is, $\frac{1}{3}b +$ or $-$ the ſum or difference of the cubic roots of $\sqrt{\frac{1}{4}qq - \frac{1}{108}p^2b^2 + \frac{1}{27}b^3q - \frac{1}{6}bpq + \frac{1}{27}p^3} \pm \frac{1}{27}b^3 + \frac{1}{2}q - \frac{1}{6}bp$ (*viz.* $+$, if $\frac{1}{27}b^3 + \frac{1}{2}q$ be greater than $\frac{1}{6}bp$, otherwiſe $-$) the ſum, when $\frac{1}{3}bb$ is greater than p, the difference when leſs: And in the other formula's, the root does always conſiſt of the ſame parts, changing the ſigns $+$ and $-$, as will be eaſily ſeen upon trial: But theſe roots are readily enough found by means of the logarithmetical table of verſed ſines; *viz.* if the coefficients are either ſurds or fractions, and the roots not to be expreſſed in numbers, as moſt commonly is the caſe: Now this is the rule; in the firſt and ſecond formula's, if $\frac{1}{3}bb$ be leſs than p, let $\frac{1}{3}p - \frac{1}{9}bb = d$, and putting for the radius the difference between $\frac{1}{6}bp$ and $\frac{1}{27}b^3 + \frac{1}{2}q$ (that is, H R) in the firſt formula, and the difference between $\frac{1}{6}bp + \frac{1}{2}q$ and $\frac{1}{27}b^3$ in the ſecond, let the angle, whoſe tangent is $d\sqrt{d}$, be found; then as the co-ſine of this angle to its verſed ſine, ſo the difference, which is taken for radius, to a fourth; the cube root of which is had by taking $\frac{1}{3}$ of its logarithm; then dividing $\frac{1}{3}p - \frac{1}{9}bb$ by this cube root, let the diviſor be ſubſtracted from the quotient, the remainder will be the quantity Y &; the ſum of this remainder and $\frac{1}{3}b$ will be the root ſought, if the centre fall on the right hand of the axis; otherwiſe their difference will be the root; but if $\frac{1}{3}bb$ be greater than p, making H R radius, let $d\sqrt{d}$, or the diſtance of the paraboloid from the axis, be the ſine of ſome arch, and let its verſed ſine be multiplied into the radius, or $\frac{1}{6}bp - \frac{1}{27}b^3 \pm \frac{1}{2}q$, and taking $\frac{1}{3}$ of the logarithm of the product, its cube root will be obtained, by which let $\frac{1}{9}bb - \frac{1}{3}p$ be divided; the ſum of the quotient and diviſor, after the ſame manner added to or ſubſtracted from $\frac{1}{3}b$, will give the root ſought: And the like holds in the third and fourth formulas, except that $\frac{1}{27}b^3 + \frac{1}{6}bp \pm \frac{1}{2}q$ is to be taken for radius, and $\frac{1}{9}bb + \frac{1}{3}p$ into $\sqrt{\frac{1}{9}bb + \frac{1}{3}p}$, or $d\sqrt{d}$, for the ſine; but theſe rules will poſſibly be better underſtood by examples.

Suppoſe the cubic equation $z^3 - 17z^2 + 54z - 350 = 0$, and let the root z be ſought; here $\frac{1}{3}bb$ is greater than p, but q is

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q is greater than the cube of $\frac{1}{3}b$, and therefore it is explicable by one affirmative root only: Now $\frac{288}{9} - \frac{54}{3}$ is d, and $\frac{127}{9}\sqrt{\frac{127}{9}}$ is to be taken for the ſine, to the radius $\frac{4913}{27} + 175 - 153$, that is, $\frac{5507}{27}$; and the arch anſwering thereto is 15° 3′ 49″, the Log. of its verſed ſine is 8.5362376 added to the Log. of the radius 2.3095913 makes 0.8457889, the third part of which 0.2819276 is the Log. of the cube root 1.91394, by which, as a diviſor, dividing $\frac{127}{9}$ or d, the quotient is 7.37281; the ſum of the quotient and diviſor, encreaſed by the addition of $\frac{1}{3}b$, is the root ſought, *viz.* 14.9534, &c.

Having thus diſpatched cubic equations, let us proceed to biquadratics; and theſe have always either none, or 2, or 4 true roots, the determination of which depends partly on the co-efficients, partly on the ſign and magnitude of the abſolute number given: In the conſtruction of the equation $z^4 - bz^3 + pz^2 - qz + r = 0$; BD, Fig. 11. is $= \frac{1}{4}b$, $AB = \frac{1}{16}b^2$, $BK = \frac{1}{2}$, or $\frac{1}{2}$ the parameter, $KC = 2AB = \frac{1}{8}bb$, $KE = \frac{1}{8}bb - \frac{1}{2}p$, $AE - \frac{1}{2} = \frac{3}{16}bb - \frac{1}{2}p$, $FE = \frac{1}{16}b^3 - \frac{1}{4}bp$, and $EG = \frac{3}{16}b^3 - \frac{1}{4}bp + \frac{1}{2}q$; which done, a circle from the centre G with the radius $\sqrt{GD^2 - r}$ will interſect the parabola, either in none, or 2, or 4 points, from whence perpendiculars let fall on DH will give all the roots z; but that they may be 4, it is evident that the centre of the circle ſhould be found ſomewhere within a ſpace, from any point of which, three perpendiculars may be let fall upon the curve of the parabola; and alſo that the radius be leſs than the greateſt of thoſe perpendiculars, and greater than the middle one; but if the centre be poſited without this ſpace, ſo that there cannot but one perpendicular be let fall upon the parabola, and the radius be greater than it; or if it be leſs than the middle one of the three perpendiculars, but greater than the leaſt of them, then there can be but two roots; but there is none at all, when the radius $\sqrt{GD^2 - r}$ is leſs than the leaſt of the three, or one, as often as there is but one: Now it remains to enquire, of what kind this ſpace is, by what limits it is diſtinguiſhed, and under what conditions the radius of the circle is leſs or greater than the above-mentioned perpendiculars; and firſt of all we muſt ſhew, how a perpendicular is to be let fall upon the parabola: Let ABC, Fig. 12.

be a parabola; A E its axis; A U half the parameter; G the point from whence the perpendicular is to be let fall; let G E be drawn perpendicular to the axis, and let U E be biſſected in F, and erecting the perpendicular F H on the ſame ſide of the axis; let F H be $= \frac{1}{4}$ G E; then a circle, deſcribed on the centre H, with the radius H A, will interſect the parabola either in three points, or one, Z, to which the right lines G Z being drawn, will be perpendicular to the curve of the parabola; but that there may be three ſuch interſections, the centre H, Fig. 10. ſhould be ſo poſited, as that it may be within the ſpace included by the paraboloids, that is, that F H may be leſs than $\sqrt{\frac{8}{27}\text{UF}^3}$, or FH^2 leſs than the cube of $\frac{2}{3}$ U F, and ſo G E $= 4$ F H will be leſs than $4\sqrt{\frac{8}{27}\text{UF}^3}$; that is, the ſquare of G E will be leſs than $\frac{16}{27}\text{UE}^3$; therefore, theſe limits coincide with two paraboloids of the ſame kind with thoſe which were uſed in cubic equations, but whoſe parameter is twice leſs; *viz.* $\frac{27}{16}$ of the parameter of the parabola, that is, $\frac{27}{8}$ of A U; and therefore, it is that very curve, by whoſe evolution the parabola is deſcribed, as *Huygens* hath demonſtrated; and which, the line D F, Fig. 11. a perpendicular to the parabola in the point D, always touches; but the point P, in which the right line D F touches the paraboloid, is the centre of a circle, which, being deſcribed with the radius D P, coincides with the parabola in the point D, or hath the ſame curvature with it, as is manifeſt: Having therefore deſcribed ſuch paraboloids U X P, U N Δ on each ſide of the axis, it is plain, that unleſs the centre of the circle be placed within theſe limits, it cannot interſect the parabola in more than two points; from whence we may determine, under what conditions, the co-efficients of the intermediate terms are reſtrained in biquadratic equations, that ſo there may be 4 roots; and at firſt ſight it is plain, that p cannot be greater than $\frac{3}{8}bb$ (*viz.* in thoſe formulas wherein it is $+p$) nor q than $\frac{1}{16}b^3$: But in general, $\frac{1}{16}b^3 \mp \frac{1}{4}pb \mp \frac{1}{2}q$, that is E G, the diſtance of the centre from the axis, ſhould be leſs than E H $= 4\sqrt{\frac{1}{27}\text{UE}^3}$, that is, (becauſe U E $= \frac{3}{16}bb \mp \frac{1}{2}p$) than $\frac{1}{4}bb \mp \frac{2}{3}p\sqrt{\frac{1}{16}bb \mp \frac{1}{6}p}$; the ſigns + and — being left doubtful, that ſo they may be varied according to the nature of any equation, as was ſhewn above in cubics: As for the limitation of the laſt term r, it cannot be found with the ſame eaſe; and that becauſe, the letting fall a perpendicular upon the curve of a parabola, is a ſolid problem, which cannot be reſolved without the ſolution of a cubic equation; therefore in the firſt place, let the ſecond term be wanting, or if it be in the equation, let it be taken away, ſo that it may have this form $z^4.\ *.\ pz^2.\ qz.\ r. = 0$; and if it be $-r$, it is always explicable by two or four roots; and that there may be four, the centre of the circle ſhould be poſited within the above-mentioned paraboloids, or that it may be $-p$, and qq may be leſs than $\frac{8}{27}p^3$, or the cube of $\frac{2}{3}p$; then let the roots of this equation $y^3.\ *.\ \frac{1}{2}py.\ \frac{1}{4}q = 0$ be obtained, the quantities p and q having the ſame ſigns, as in the biquadratic; and theſe roots are found expeditiouſly enough by the table of ſines: But having found thoſe three y, which are ordinates to the axis of the parabola, from the points where perpendiculars do fall on its curve, *viz.* YZ, Fig. 12. then $pyy - 3y^4$ of the leſſer y will denote the greateſt quantity r, if it be $-r$, than which if r be leſs, the equation will have four roots, otherwiſe but two; but if it be $+r$, it ſhould be leſs than $3y^4 - pyy$ of the middle y; for if it be greater, it can have but two roots; at leaſt if r be leſs than $3y^4 - pyy$ of the greateſt y; but if it be greater than this, the equation is not explicable by any true root at all; but theſe ſame limits are otherwiſe expreſſed by the quantity q; *viz.* $\frac{1}{2}qy - y^4$ in the firſt caſe, $y^4 - \frac{1}{2}qy$ in the ſecond, and $y^4 + \frac{1}{2}qy$ in the third: But it may happen, that the two leſſer quantities y may not be far diſtant from each other, whence it is that both the perpendiculars are greater than the right line GA, *viz.* when qq is greater than $\frac{4}{27}p^3$, but leſs than $\frac{8}{27}p^3$, the centre falling within the ſpace contained between the paraboloids of both the figures 10 and 11; in this caſe if it be $+r$, there can be but two roots, $y^4 + \frac{1}{2}qy$ of the greateſt y being greater than r, otherwiſe none; but if $\frac{1}{2}qy - y^4$ of the leaſt y be greater than r marked with the ſign $-$, but r be greater than $\frac{1}{2}qy - y^4$ of the middle y, then there will be four roots; but two only, if r be found greater than the former, or leſs than the latter; but if in the equation it be $+p$ or $-p$, and qq be greater than $\frac{8}{27}p^3$, the equation $y^3.\ *.\ \frac{1}{2}py.\ \frac{1}{4}q$ is explicable by only one root y; that is, there can be but one perpendicular only let fall from the centre of the circle; whence it may be certainly concluded, that there can be but two roots only in the given equation, whoſe ſum, if it be $-r$, is encreaſed with the quantity r; but if it be $+r$, having obtained the quantity y, that quantity r ſhould be leſs than $y^4 + \frac{1}{2}qy$; for if it be greater, the equation propoſed is abſurd and impoſſible.

It would be both tedious and needleſs to run over all the equations of this kind, ſince it is evident from what has been already ſaid, which are negative and which affirmative roots; and that the limits of theſe roots are derived from the quantities y found: But for an example, which any one may imitate in other caſes; let it be propoſed to diſcover the limits or conditions, under which, there may be four affirmative roots in a biquadratic equation; now this will be as often as the centre of the circle G is poſited in the ſpace U P K, Fig. 11. and alſo as often it is $+ r$, or the radius of the circle is leſs than G D: Whence it is plain, that the equation, here deſigned, is of this formula, $z^4 - bz^3 + pz^2 - qz + r = 0$, and that p cannot be greater than $\frac{3}{8} bb$, nor $\frac{1}{4} pb$, in this caſe, than $\frac{1}{16} b^3 + \frac{1}{2} q$; again, it is neceſſary that $\frac{1}{4} bb - \frac{2}{3} p$ in $\sqrt{\frac{1}{16} bb - \frac{1}{6} p}$ ſhould be greater than $\frac{1}{16} b^3 + \frac{1}{2} q - \frac{1}{4} bp$; and from theſe limits it will be plain, that the centre is contained within the ſpace U P K; but in order to determine the quantity r, this cubic equation muſt be firſt ſolved, $y^3. *. - \frac{3}{16} b^2 - \frac{1}{2} py = \frac{1}{32} b^3 + \frac{1}{4} q - \frac{1}{8} pb$, and we ſhall have the points, upon which perpendiculars from the centre do fall to the curve of the parabola: Now having found the three values of this y, the quantity r ſhould be leſs than $\frac{3}{256} b^4 + \frac{1}{4} bq - \frac{1}{16} bbp + 3y^4 - \frac{3}{8} b^2 yy + pyy$ of the middle y, but greater than $\frac{3}{256} b^4 + \frac{1}{4} bq - \frac{1}{16} bbp + 3y^4 - \frac{3}{8} b^2 y^2 + pyy$ of the leaſt y; but if r exceed theſe limits, there can be but two roots obtained; laſtly, if $\frac{3}{256} b^4 + \frac{1}{4} bp - \frac{1}{16} bbp + 3y^4 - \frac{3}{8} bbyy + pyy$ of the greateſt y be leſs than r, than the equation propoſed is impoſſible: It alſo happens that there are four affirmative roots, when the centre G is poſited in the little ſpace U T S; *viz.* drawing R T S perpendicular upon the middle of the ſuppoſed line A D; but this happens, when p is greater than $\frac{5}{16} bb$, and $\frac{1}{4} bb - \frac{2}{3} p \sqrt{\frac{1}{16} bb - \frac{1}{6} p}$ greater than $\frac{1}{8} pb - \frac{5}{128} bbb - \frac{1}{2} q$; in which caſe always two, ſometimes three of the roots are greater than $\frac{1}{4} b$: But it is to be noted here, that the limit ariſing from the leaſt y, is ſometimes negative, or leſs than nothing, *viz.* as often as the greateſt of the three perpendiculars is greater than G D, Fig. 11. if this happen, the quantity $+ r$ may be diminiſhed to nothing by the limit preſcribed from the middle y; but the defect of a limit from the leaſt y, ſhews how great $- r$ may be in the equation, if there be three affirmative and one negative root; which if it exceed, there can be but two, one affirmative and the other negative: And all this is demonſtrated hence, that the above-mentioned limits of the quantity r are the differences of the ſquares of the line G D, and the perpendiculars to the curve of the parabola:

But becauſe of the perplexing cautions ariſing from the diverſity of ſigns in theſe equations, it is always better to take away the ſecond term, and then to ſeek out the number of roots and the ſigns, according to the rules already delivered; eſpecially if theſe quantities are not very different from each other; but of theſe four affirmative roots, two are always leſs than $\frac{1}{4} b$, and two greater; *viz.* if D G be leſs than A G, or $\frac{1}{4} p b$ than $\frac{1}{64} b^3 + q$; but three are always leſs than $\frac{1}{4} b$, as often as the mean perpendicular, or that found from the mean y, is greater than A G, or $\frac{1}{4} b^2 y$ greater than $3y^3 - py^2$ of the ſame mean y; the fourth and greateſt root is greater than the greateſt $y + \frac{1}{4} b$, and it is equal to the difference of b and the ſum of the other three roots, and therefore it is leſs than b.

Perhaps, thoſe that more perfectly underſtand the nature of the parabola, may be able to do all theſe things after a more compendious manner; but there is ſome reaſon to doubt, whether all theſe quantities b, p, q, r can be rightly determined without the reſolution of a cubic equation; for whatſoever is done in this affair by plane equations, exhibits, not the true limits, but ſome approximations only.

The Obliquity of the Ecliptic *and Elevation of the* Pole *continue unaltered.* Phil. Tranſ. N° 190. p. 403.

WHether the poles and axis of the earth be really fixt in the globe, or ſubject to be transferred from one place to another, is an old enquiry, tho' revived by Dr. *Hook* in his ingenious eſſays on the great cataſtrophe's and mutations, which, in all appearance, have befallen the ſurface of the earth; a neceſſary conſequence of ſuch a tranſlation of the poles would be the change of the latitudes of places, which would encreaſe in thoſe regions, towards which the poles approach, and decreaſe in thoſe from which they recede; and under the meridian, 90° removed from that in which the poles ſhift, the latitudes continuing the ſame, the meridian line would only alter; but no two places, conſiderably different in latitude, can be ſuppoſed, wherein, if there be any ſenſible motion of the poles, it ſhall not be perceived by the alteration of the latitude of one or both of them: The accurate M. *Wurtzelbaur*, hath furniſhed us with the means of examining this hypotheſis by obſervation; for having taken the meridian altitudes of the ſun at *Nuremberg*, about the two ſolſtices, in the year 1686, *June* 10th; he found the meridian altitude of the ſun 64° 2′ 20″, and the next day 64° 2′ 25″; and on *December* 14th (three days after the a new revolution produced, differing both in time and poſition from the old, the author undertakes not to diſpute; ſuch a ſuppoſition would likewiſe include a change of the length of the year, and eccentricity of the earth's orbit; for which yet we have no ſort of authority.

Of the Diſeaſes *of* Dogs, *and an Account of ſeveral* Receipts *for the Cure of their* Madneſs, *and of thoſe bitten by them*; *by Sir* Theodore Mayern. Phil. Tranſ. N° 191. p. 408.

DOGS are ſubject to theſe ſeveral ſorts of madneſs or rather diſeaſes. 1. The hot madneſs, which is incurable; they run at every thing, and then they can hold out but four days. 2. The running madneſs, which is likewiſe incurable; they fly only at dogs, and that by fits, and they may ſometimes hold out nine months. 3. *La rage mue*, which is a diſeaſe in the blood. 4. The falling madneſs, which ſeizes on the head, and is a ſpecies of epilepſy. 5. The blaſting or withering, this lies in the bowels, which are exceedingly ſhrunk up. 6. The ſleepy diſeaſe, cauſed by little worms in the mouth of the ſtomach; theſe dogs die ſleeping. 7. The rheumatic diſeaſe, in this the head is very much ſwelled, and the eyes become yellow: Theſe five laſt are not properly madneſs, but ſome other diſeaſes; when thus affected, they will eat nothing nor at any time when ſick, they live eight or nine days without hurting any body, and then die of hunger: The two firſt diſeaſes are communicated by the breath of dogs, as the plague amongſt men; the latter are likewiſe contagious, but curable.

Receipts for the bite of mad dogs. Take *Virginia* ſnake-root, and flowers of St. *John's Wort* gathered in their prime, of each equal parts, let them be made into very fine powder; the doſe is from a ſcruple to a dram, to be taken in any ſort of decoction prepared with ſpecifics: To a horſe give 2 drachms; to a dog from 1 to 1 ½ drachm; and this before the ninth day after the bite.

Another; Take leaves of rue, picked from the ſtalks and bruiſed, 6 ounces; *London-Treacle* (or which is better, *Venice-Treacle*), garlick puled and bruiſed, and fine filings of tin, of each 4 ounces; put them into 4 pound of canary, or good white wine; or in caſe of a hot conſtitution, into the ſame quantity of ſtrong and well worked ale, in an earthen veſſel well ſtopped; then let it gently digeſt or boil *in Balneo* for 4 hours, keeping in the ſteam, and then preſs and ſtrain it: The doſe is from 2 to 3 ounces, (and in ſome perſons more) to be taken every morning for 9 days: The patient muſt faſt for 3 days after it, and the dreggs that remain after expreſſion muſt be applied to the wound and renewed every 24 hours. *N. B.* This medicine muſt be taken before the ninth day after the bite, leaſt the poiſon ſeize the blood too ſtrongly: It muſt be given cold, or at leaſt a little warmed: A double quantity may be given to a beaſt ſoon after the bite: This remedy having been adminiſtred ſeveral times, was never found to fail.

Another; Pluck the feathers from the breech of an old cock, and apply it bare to the wound; if the dog were mad, the cock will ſwell and die, and the patient will do well; but if the cock dies not, the dog was not mad; if the wounds be very ſmall, it is proper to open them with a lancet.

Another; Let the patient be nine times plunged in the ſea, faſting, as ſoon as poſſible after the bite: Waſh the bitten part with a lee of the aſhes of oak-wood and urine, and apply a cataplaſm of *London Treacle*, *Alliaria*, or hedge-garlick, rue and ſalt.

Take dried rue and ſcordium, of each two drachms, *Virginia Snake-root* 1 ½ drachms, flowers of St. *John's Wort* 3 drachms, fine filings of tin, and garlick cut ſmall, of each 4 drachms, *London Treacle* an ounce: Let them be all beaten, and well mixed together, adding ſyrup of lemon peels ſufficient to make it into an electuary; divide this into 9 equal parts, one to be taken every day, drinking after it a ſmall draught of good ſtrong ale; let the patient walk after it, and not eat till 4 hours after: Uſe as little of the abovesaid ſyrup of lemon peels as poſſible; if it cannot be had, a ſyrup made of *Malaga-wine*, adding as much ſugar as it can diſſolve, may ſerve the purpoſe: Make up of this electuary 4 ½ ounces at a time, that ſo the doſe may be half an ounce.

The Zirchnitzer Sea *in* Carniola *deſcribed by M.* J. Weichard Valvaſor. Phil. Tranſ. N° 191. p. 411.

THIS lake was by the ancients called *Lugea Palus*, by the moderns *Lacus Lugeus*, tho' at preſent its *Latin* name be *Lacus Cirknicenſis*, in *High Dutch Zirchnitzer See*, and in the *Carniolan* tongue *Zirknisko Jeſero*; the reaſon of the ancient name is either unknown or very uncertain, but the original of the modern one is more certain, it being derived from the neighbouring town *Zirchnitz*, which had its name from a chapel of the Virgin *Mary*, that at firſt ſtood alone, but now the town is built round it; this chapel was at firſt no great edifice, and therefore called the little chapel, which in the language of the country is *Zirkviza*; whence the lake was called *Zirkviſko Jeſero*, or the chapel lake, but now by the change of *v* into *n*, *Zirkniſko Jeſero*: It is at the diſtance of ſix *German* miles from the capital city of the province *Labac*; and is a good *German* mile in length, or better than 4000 geometrical paces, and about half as much in breadth; its ordinary depth is 10 cubits, its leaſt 5 or 6, rarely 3, but its greateſt is 16 cubits: It is on all hands ſurrounded with woody mountains, which on the ſouth and weſt ſides are very high, and 3 miles broad, running far into *Turky*, and are nothing but frightful ſtony deſarts overgrown with trees; on the north and eaſt ſides, between the mountains and the lake, there is a ſmall territory, which, tho' narrow, is very pleaſant, having one town, three caſtles, and nine villages, and adorned with 20 churches; as may be ſeen in the map, Fig. 1. Plate XIII. In the mountain called *Javornick* ſtanding near the lake, there are two holes, or exceeding deep precipices, in which wild-pigeons rooſt all winter, going in autumn, and coming out in the beginning of ſpring; what they live upon in theſe caverns is unknown, but M. *Valvaſor* takes it to be nitrous ſand: In the other hill, called *Slivenza*, according to the popular notion, witches hold their aſſemblies, becauſe that *Ignes Fatui* are often obſerved there; on the top of this hill is a hole of an unknown depth, which emits noxious ſteams, ſuppoſed to cauſe tempeſts of thunder, lightning and hail; and for this reaſon the prieſt of *Zirchnitz*, every *Whitſun-Monday*, goes in proceſſion to the hole, and uſes over it a certain form of exorciſm: Eight rivulets continually diſcharge themſelves into this lake; the two leaſt are called *Bellebrech* and *Treſenz*; the third is the fountain *Oberch*, out of which a great deal of water guſhes with violence; the fourth, fifth, and ſixth called *Steberziza*, *Lipſinziza* and *Seromſchiza*, may for their bigneſs deſerve the name of rivers; the ſeventh, called *Martinſchiza*, breaks out at a cleft in the rock; the laſt, called *Cirknizer-bach*, is a pretty large river: Now this lake being every where ſurrounded with mountains, and overflowing no where, nature hath given it two viſible channels, or ſtrong caverns, called *Velka-Karlouza* and *Mala-Karlouza*, by which the water runs under the mountain, and a third unknown ſubterraneous paſſage, which doubtleſs communicates with the other two, as ſhall hereafter appear: Theſe, having run half a *German* mile, come out on the other ſide of the mountain, near the chapel of St. *Cantian*, Fig. 2. in a deſart place, at a ſtony cave A, and becomes the river called by the inhabitants *Jeſero*, that is, the *Lake*; this river *Jeſero*, marked B, is pretty large, and, having run a quarter of a mile, enters a wide ſtony cavern I, running ſlowly under the hill to the diſtance of a good muſket-ſhot; then coming out again on the other ſide, after it has run thro' a ſmall plat *m m*, it enters a third cavern or grotto C, wherein having paſſed 50 paces, it runs no longer calmly as before, but with a great noiſe and roaring falls down a channel of ſtone which is very ſteep: In *June* 1678 M. *Valvaſor* went in a ſmall fiſher-boat under the mountain thro' the cavern I, and entred the grotto C, till he came to the abovesaid falls, without any danger or trouble, the paſſage being ſufficiently wide: It muſt be obſerved, that the valley, wherein this river *Jeſero* runs, is exceeding ſteep, but the plat of ground *m m* is plain and ſtony, of an oval form, and ſurrounded as it were, with a very high rampart K K K, ſo ſteep that it would be impoſſible for a cat to climb out of it, unleſs at one place, at which a man may make a ſhift to go up and down, tho' not without endangering his life; the path being in ſome places not above 3 or 4 inches and no where above 6 inches wide: In 1684 M. *Valvaſor* deſcended by a ſteep and narrow paſſage at D, and came to a cave bigger than any church, thro' which the river *Jeſero* runs; here he found ſeveral figures of ſtone, the workmanſhip of nature, and ſtrange holes and caverns in the earth; but becauſe the water was then up he could go no farther; at other times, when the water is down, one may go with lighted torches a great way under ground; and it is ſaid that very odd figures are formed by the petrified water; and amongſt the reſt one reſembling a weaver at work: But to return to the lake, about St. *James*'s *Tide*, and ſometimes not till *Auguſt*, the water retires, and it is dry; but it fills again, and that moſt commonly in *October* or *November*, yet ſo as not to obſerve any certain period; for ſometimes it has been dry twice or thrice a year; as in 1685 it was dry in *January*; again the water began to retire on the 15th of *Auguſt*, and it was quite empty by the 8th of *September*; and in 1687 it was thrice empty, which made the fiſhing poor and inconſiderable; ſometimes again, tho' but ſeldom, it has happened to be 3 or 4 years together full of water, and then is the beſt fiſhing; but it was never obſerved, that this lake was dry for a whole year together: The right of fiſhing in this lake, upon certain terms agreed on, did in 1687 belong to the lordſhips or caſtles following,

lowing, *viz. Haaſperg*, *Steegberg*, *Laas*, *Schneeperg*, *Aveſperg*, and *Sitticium*, a monaſtery of *Ciſtertian* monks: There are three iſlands in this lake; *viz. Mala-goriza* and *Velka-goriza*, which are uninhabited; the third is a very agreeable iſland called *Vornek*, which is pretty large, having on it a village of four houſes, called *Ottock*; above this town upon a little eminence ſtands a church, which is no ſmall ornament; in this iſland are fields, meadows, paſtures, woods, gardens, orchards, and all things neceſſary for life: There is alſo a very fine peninſula all covered with wood, called *Dorvaſek*; when the lake is up, and one comes in a boat between the iſland *Vornek* and this peninſula, the farther part of the lake, lying under the mountain very well reſembles a curious port for ſhipping; at the farther end, when the water retires, rows of ſtakes appear, a ſign that formerly there was a bridge here, and therefore at this day it is called the old bridge: In this lake are ſeveral pits in the ſhape of baſons or caldrons, which are not all of the ſame depth or breadth; their breadth being from 20 to 60 cubits, more or leſs; and the depth from 8 to 20 cubits; in the bottom of the pits are ſeveral holes, at which the water and fiſh retire, when the lake ebbs: The principal pits, in which they fiſh, are 18, beſides ſeveral others of leſs note, ſituated and named, as is repreſented in the map, Fig. 1. In the months of *June*, *July*, and *Auguſt*, when this lake begins to retire, it grows quite dry in 25 days, if no great rains fall; and the aboveſaid 18 pits are all emptied, one after another, in a certain conſtant order of time: When the lake begins to ſink, which appears by a certain ſtone; the inhabitants of the town of *Oberdorf* or *Seedorf* give notice thereof to all the neighbouring fiſhermen, appointed by the ſeveral lords, who have the right of fiſhing: The people of this town have orders, not only to obſerve the falling away of the water, but likewiſe to take care that no body preſume to fiſh in the lake, when it is full of water.

1. The firſt pit, called *Malijoberch*, is not properly a pit like a caldron, but only a depreſſion of the bottom without any holes in it; but much graſs and weeds grow in it, and a great deal of fiſh is caught therein; three days after the water begins to ebb, this pit is emptied; then the pariſh clerk of *Seedorf* gives notice thereof by tolling a bell; and all the inhabitants of the town without diſtinction of age or ſex go a-fiſhing ſtark naked: The fiſh they catch is divided into two parts; one they give to the prince of *Eckenberg*, as lord of the manour,

nour, the other is their own. 2. The pit *Velkjoberch* is empty the third day after *Malijoberch*; the manner and right of fiſhing are the ſame as in that. 3. Four hours after this, the pit *Kamine* begins to empty; here they generally fiſh with a trawle, as in ſeveral other pits of leſs note. 4. *Sueiuskajamma* ſinks an hour after *Kamine*, and in it much fiſh is taken, and plenty of large crabs; but they are lean and of no good taſte. 5. The fifth pit *Vodonos* dries up in 5 days after *Kamine*; in this and the other following pits, they fiſh with a long net or ſayne; and in it they can have no more than 5 or 6 draughts, becauſe of the ſwiftneſs wherewith the water runs away at the holes in the bottom, carrying with it the fiſh with great violence under ground; ſometimes when fiſhermen are not nimble enough, they can ſcarcely have two draughts before the water is gone; to prevent which, they have a mark near this pit; *viz.* the ſtone *Ribeskehamen*, that is, the fiſher's ſtone; which, as ſoon as it begins to appear on the receſs of the water, intimates, that it is time to begin the fiſhing. 6. The pit *Louretſchka* is evacuated a day and a half after *Vodonos*; the fiſhing is after the ſame manner, and the ſame caution neceſſary, becauſe of the ſudden receſs of the water. 7. The water leaves the pit *Kralondour* 12 hours after *Louretſchka*; and in 3 days after that, 8. The pit *Reſcheto*; in this latter in 1685, after the lake had been for ſome years without being dry, there were taken at the firſt draught 21 cart load of fiſh, at the ſecond 17, and at the third nine. 9. The pit *Ribeskajamma* becomes dry at the ſame time with *Reſcheto*, which is that next to it; in this pit they fiſh under ground, which is no unpleaſant curioſity, and in this it differs from all the other pits; for there is at the bottom a great hole in the ſtones, by which men may eaſily go down with lighted torches, as into a deep ciſtern, under which is a large cavern like a vault, whoſe bottom or pavement is like a ſieve full of little holes, by which the water runs away, leaving the fiſh dry, where they are caught. 10. *Retbje* is emptied two hours after *Ribeskajamma*, and is of no great conſequence for fiſh; an hour after this the pit, 11. *Sittarza*; and in five or ſix hours more, 12. *Liparza* becomes dry. 13. The third day after *Reſcheto*, the pit *Gebno* is evacuated; in this they rarely fiſh with nets; the holes in the bottom being ſo ſmall, that they exceed not a man's arm, ſo that all the great fiſh are left behind in the pit. 14. Two days after *Gebno*, the pit *Koteu* becomes dry; in this they ſometimes take the fiſh as in the former; but the holes being larger let bigger fiſh paſs thro'. 15. The pit *Ainz* is emptied four or five hours after *Koteu*; in this they ſeldom ſuffer the water to run off without uſing their nets; by reaſon of a great hole in the bottom, by which the great fiſh may eſcape. 16. The pit *Zeſlenza* ſubſides in three hours after *Ainz*, in this they always fiſh with nets; as in 17. *Pounigh*, which is emptied the next day after *Koteu*. 18. The laſt pit called *Leviſche* is evacuated the third day after *Pounigh*, that is, the 25th day from the beginning of the receſs of the water of the lake; ſo that in 25 days the fiſhing of this lake is over: Into this laſt pit there fell a flaſh of lightning, which ſtunned a great number of large fiſh, ſo as to fill 28 carts, by which is meant as much as one horſe can draw; but if they are taken up and put into freſh water, they ſoon recover, otherwiſe they die.

The fiſhing being thus over, a ſignal is given by tolling a bell in the chapel of St. *John Baptiſt*, near the town *Cirknitz*; upon which all the inhabitants of the neighbouring villages, and of *Cirknitz*, without diſtinction of age or ſex, go for the moſt part ſtark naked into the lake, and look for fiſh amongſt the weeds and ſedge, and in the ſmaller pits; and many of them creep into the ſubterraneous caverns and paſſages, and find ſtore of large fiſh there, having full liberty to ſearch all over the lake, except in the pits *Pianze*, *Narte*, and *Velkjoberch*; there are, beſides theſe, ſome other pits in the lake, as [a] *Skednenza*, [b] *Mala* and [c] *Velkabobnarze*, in which they alſo fiſh; as likewiſe in [d] *Malakarlouza*, and [e] *Velka-karlouza*; in both theſe they go far under ground with lighted torches, and find fiſh, but theſe pits are of no great value: In *Velkabobnarza* one may go in at great holes, and deſcend many fathoms under ground; theſe two names *Velka* and *Malbobnarza* ſignify, in the *Carniolan* tongue, the greater and leſſer drummer; nor is it without reaſon that theſe pits are ſo called, for when it thunders and lightens, there is heard in theſe two pits, as it were, the ſound of many drums beating: The two pits [f] *Narte* and [g] *Pianze* are never empty, but always remain fenny, when the reſt of the lake is quite dry; it is thought that the fiſh lay their ſpawn in theſe pits, and therefore it is prohibited to fiſh therein; they abound in horſe-leeches; the method, they take to get rid of them, when they faſten on their bodies, is to get another perſon to piſs upon the leech, which makes it let go its hold: There are in the mountain near the lake, but ſomething higher than it, two large and frightful ſtony caves, the one called (α) *Urainajamma*, the other (β) *Sekadulze*, which, tho' at a great diſtance from each other, yet have the ſame effect; *viz.* when it thunders and lightens, they emit water with a prodigious force, eſpecially the latter to 3 or 4 fathoms, as if it were forced by a fire engine, and with it ſometimes a great number of ducks, and ſome fiſh: When it rains moderately, the water ſpouts with great violence two or three fathoms perpendicularly out of the pits *Koteu* and *Zeſtenza*; it likewiſe comes forcibly out of the ſpring (*r*) *Treſenz*, as alſo out of *Velkjoberch*, this latter yielding abundance of fiſh and ſome ducks; but when it rains very hard and long together, eſpecially when it thunders, then the water breaks out with very great force, not only from the aforeſaid pits, holes and caves, but likewiſe at ſeveral thouſand other little holes all over the bottom of the lake, and which, when the lake is dry, drink up the waters of the 8 rivulets that run into it; the water is thrown up ſeveral fathoms, from ſome perpendicularly, from others obliquely, ſo that there is no ſight more pleaſant than this; out of the pits *Vodonos*, *Reſcheto*, and ſome others, which have holes at the bottom, there comes with the water a great quantity of fiſh; if there are great rains, the 8 rivulets are ſwelled much; ſo that this lake, in 24 hours time, will, from quite dry, become full of water, and ſometimes in 18 hours; tho' at other times it hath been known to be three weeks in filling; but it is a conſtant obſervation, that thunder and lightning contribute much to fill it ſpeedily.

This lake, being thus by turns wet and dry, ſerves the inhabitants for ſeveral purpoſes; for, firſt, whilſt it is full of water, ſeveral ſorts of wild-geeſe, duck and other water fowl, as herons, ſwans and the like reſort thither; in the next place, as ſoon as the lake is emptied, they pluck up the ruſhes and weeds, which make excellent litter for cattle; in twenty days after it is fully dry, they mow a great quantity of hay upon it; after the hay is in, they plow it and ſow millet therein, which ſometimes is deſtroyed by the too ſudden breaking out of the water, but it generally comes to maturity; whilſt the millet is on the ground, they catch a great number of quails; after the millet is in, there is good paſture for cattle; when the lake is dry, there is great variety of game; there flocking thither from the neighbouring woods and mountains, plenty of hares, foxes, deer, ſwine, bears, &c. immediately on the receſs of the water; when the lake is full it affords the diverſion of fiſhing; in winter it will be ſo firmly frozen, as to bear all ſorts of carriages, which is a great conveniency to the people for fetching their wood and other neceſſaries; laſtly, at the time of the receſs of the water it affords great plenty of fiſh; and what is moſt ſurpriſing is, that all this happens in the ſame place, and in the ſame year, providing the lake be early dry, and it fill not too ſoon; but it is to be noted, that the hay does not grow, nor is the millet ſown all over the lake, but only in the more fertile places.

The fiſh, taken in this lake, and which are well taſted, are 1. the *Muſtela Fluviatilis*, or *Eel-pout*, ſome of them weighing 2 or 3 pounds. 2. *Tench*, ſome of them weighing 6 or 7 pounds. 3. *Pikes* in very great plenty, of 10, 20, 30, and ſome 40 pound weight; in the ſtomachs of theſe latter it is common to find whole ducks; *Crabs* are found no where but in the pits *Kamine* and *Suciuskajamma*, they are large but ill-taſted.

The cauſe or rather the *Modus* of all theſe wonderful phænomena in the lake of *Zirchnitz*, is according to M. *Valvaſor*, as follows: There is under the bottom of the lake, another ſubterraneous one, with which it communicates by the ſeveral holes above deſcribed; there are alſo one or more lakes under the mountain *Javornick*, but whoſe ſurface is higher than that of the lake of *Zirchnitz*; this upper lake is poſſibly fed by ſome of thoſe many rivers which in this country bury themſelves under ground; it hath a paſſage ſufficient for diſcharging the waters brought into it; but when it rains, eſpecially in thunder ſhowers, which are the moſt ſudden, the water is precipitated with great violence down the ſteep vallies, in which are the channels of theſe rivulets; ſo that the water in this lake, being increaſed by the ſudden rains, ſwells preſently, and finding ſeveral holes or caverns in the mountain higher than its ordinary ſurface, it overflows by them into the ſubterraneous lake, under that of *Zirchnitz*, into which the water aſcends by the ſeveral holes or pits in the bottom thereof, as alſo by viſible paſſages above ground, ſuch as *Urainajamma*, *Secadulze* and *Treſena*: That ſome of theſe paſſages bring fiſh, others duck and fiſh, others again water only, ſeems to depend on the poſition of the internal mouths of theſe ſubterraneous channels; for, if they be ſo poſited as to draw off the water from the ſurface of the upper lake, on which the ducks, ſwim, they muſt needs be carried away by the ſtream into theſe caverns, and come out with the water; but if the channels open into the upper lake under the ſurface of the water, and from thence aſcend obliquely for ſome ſpace before they begin to deſcend, then the water they convey comes from beneath the ſurface, and conſequently brings only fiſh along therewith; the pits, that yield water alone, may well be ſuppoſed to be fed by paſſages too narrow to ſuffer the fiſh to paſs, tho' their number may make the quantity of water they emit to be very conſiderable.

The manner of the falling away of the water, or emptying of the lake, M. *Valvaſor* explains thus; after a long drought, all the ſprings that feed the upper lake under *Javornick* are much decreaſed, ſo that wanting freſh ſupplies, it ceaſes to run over by the ſeveral channels juſt now mentioned; hence the lake of *Zirchnitz*, and that under it, are fed only by the eight rivulets that always fall into them; and then the water retires faſter than it comes in, both by the channels of *Mala* and *Velka-karlouza*, as alſo by a ſecret ſubterraneous paſſage into the under lake, which latter alone is able to tranſmit more water than the ſaid eight rivulets afford; conſequently the lake muſt ſink, and that in a certain proportion of time, depending on the quantity of water to be evacuated, compared with the exceſs of that that runs out, above that which enters at the ſame time; and the higher pits are ſooneſt dry, the lower, lateſt, and ſo they are emptied in the order above deſcribed; and when the lake is entirely dry, then the ſaid rivulets ſoak thro' ſeveral ſmall holes in the bottom into the under lake, and all their water is carried away by the aforeſaid ſubterraneous paſſage; that there is ſuch a paſſage is very evident, and that it communicates under ground with the channels of *Mala* and *Velka-karlouza*, near St. *Cantian*, at a rocky cave, forming the river *Jeſero* is paſt diſpute; for when the lake of *Zirchnitz* is very full, and runs out at both *Velka* and *Mala-karlouza*, the river *Jeſero* at St. *Cantian* overflows, and runs with great violence; but when it only runs out at *Mala karlouza* (which is ſomewhat lower than the other) then the water of *Jeſero* is by far leſs rapid; but when the lake is ſo fallen, that it runs out at neither of the two, the river *Jeſero* is ſtill leſs, but runs with a conſiderable ſtream, till two days after the lake has been dry; after which the ſaid river becomes little, diſcharging no more water than the lake receives from the eight rivers that run into it; by which it is clearly proved, that this ſubterraneous paſſage communicates with the channels of *Velka* and *Mala-karlouza*: Hence it appears, why this lake is ſometimes dry twice or thrice a year, at other times continues full for three or four years together, but it was never known to be dry for a whole year: The ducks, which are thrown out with the water, are produced in the lake under the mountain *Javornick*; when they firſt come out, they ſwim, but are ſtark blind, without any, or but few feathers, and therefore they are eaſily caught; but in 14 days they are fledged, and recover their ſight ſtill ſooner, and afterwards they fly away in flocks; they are black, only white on the forehead; their bodies are but ſmall, reſembling ordinary wild-duck; they are of a good reliſh, but too fat, having nearly as much fat as lean: Upon opening them, there was found in their ſtomachs much ſand, and in ſome, ſmall fiſhes, in others, green ſtuff like graſs or herbs, which was the more ſurpriſing, as there never is found any green thing growing in the ſubterraneous grotto's, or lakes of *Carniola*: At a hole in the mountain called *Storſeg*, about half a *German* mile from the lake of *Zirchnitz*, near the town of *Laas*; whenever great floods of rain happen, this ſort of ducks is thrown out in great numbers with the water; and it is probable, that this cavern *Storſeg* is another paſſage from the lake under *Javornick*, which overflows and fills up the *Zirchnitz*; but this being ſomewhat higher, it never runs out, unleſs the ſaid lake be more than ordinarily ſwelled by the violence of the rains.

There is ſuch another ſubterraneous cavern, called *Grotto Podpetſchio* in *Carniola*, in the pariſh of *Gutenfeld*, diſtant four *German* miles from the city *Labac*; *a*, Fig. 3. is a hole or entrance into the rocky mountain; *b* is a great cavern in the mountain, capable of holding a hundred horſemen; *ik* is a channel big enough for a man to paſs thro' as far as the lake *o*, out of which the inhabitants draw all their water; into this lake *o* the water runs with a great ſtream thro' the channel *l*, and out of this lake it falls down a precipice into a great cavern, with ſo much noiſe, as to drown the report of a piſtol; there is alſo another channel *m*, which tends upwards obliquely, and leads to the great lake *n*, whoſe length and breadth are not known; the channel *l* either affords always an equal quantity of water, or elſe is quite dry; ſometimes it will ceaſe to run in a moment, and continue dry for ſome weeks, and then on a ſudden it will run again with great force and a frightful noiſe; from the cave *b* there is another channel *c*, divided into three others *d*, *e*, *f*; this laſt channel *f* tends obliquely downwards, till it comes to a running water in *g*, from whence one may go on to *h*, where, looking thro' a ſmall hole, one may ſee another little lake: All theſe channels are formed in a very hard rock, and are ſmooth and poliſhed, as if cut out by art: This ſubterraneous lake *n* is probably a *German* mile in length; for from the grotto *Podpetſchio*, at the diſtance of a mile, there is at a village, called *Kompale*, a great lake, which meaſured with ſuch inſtruments as miners uſe, the two lakes *Podpetſchio* and *Kompale* were found in the ſame level; and this was done twice, both when the channel *l* at *Podpetſchio* did, and when it did not run; from whence it is certain, that theſe two are only one continued ſubterraneous lake.

A Conjecture at the Quantity of Blood *in* Men, *together with an Eſtimate of the Celerity of its Circulation; by Dr.* Allen Monlin. Phil. Tranſ. N° 191. p. 433.

IN a ſheep, which alive weighed 118 pound, there was found but 5 pound and a quarter of blood, which is but $\frac{1}{4}\frac{2}{7}$ of the weight of the ſheep. In a lamb, weighing 30 pound and a half when living, there was but 1 pound and a half of blood, which is nearly a 20th part. In a duck, weighing alive 2 pound, 14 ounces, 50 grains, there was found 1 ounce and a half, and 53 grains of blood, which is leſs than a 28th part of the whole weight of the living duck: In a rabbit, weighing 10 ounces, 7 drachms, 50 grains, were found 2 drachms, 57 grains of blood, which is about a 30th part. In the right ventricle and auricle of the heart of a dog, were found 6 ounces of blood; ſuppoſing therefore, that 4 ounces only were naturally received at each diaſtole by the heart of a man, which is much larger than that of a dog; and allowing 75 pulſes to every minute, there will be 4500 in an hour, and 1800 ounces of blood tranſmitted in that time: Now, if we ſhould ſuppoſe that the quantity of blood in a man bears the ſame proportion to his weight, as that of any of the abovementioned animals to their weight, which in a lamb was the greateſt, being $\frac{1}{20}$ part, it will follow, that the quantity of circulating blood in a man weighing 160 pounds will not exceed 8 pounds, or 128 ounces; according to which computation, the blood will circulate 140 times in an hour; but let us ſuppoſe, that inſtead of 8 pounds, the maſs of blood in ſuch a man is 12 pounds, it will follow that it will circulate between 93 and 94 times in an hour, which is more than a circulation and a half in a minute: From the celerity of the motion of the blood, we may give a good account of the ſudden refreſhment from victuals, and particularly from ſuch as are liquid; as alſo of the quick paſſage of urine, and of the quick motion of the chyle into the breaſts of nurſes, without ſuppoſing unknown paſſages from the ſtomach or any other part, into the bladder and breaſts.

The beſt Time of felling Timber; *by Dr.* Rob. Plot. Phil. Tranſ. N° 192. p. 455.

THE cuſtom of felling timber in the ſouth of *England*, differs from that of *Staffordſhire*, both in the time of felling and manner of barking: In the former it is felled in the ſpring, as ſoon as the ſap is fully up, which is diſcovered by the trees putting out; and then it is barked, after the trees are proſtrate, the ſap yet remaining in their bodies; whereas, in the latter it is firſt barked, and that in the ſpring, the trees yet living and ſtanding all the ſummer, and not felled till the following winter, when the ſap is fully at reſt: In the ſpring, and ſome time after, all the trees are pregnant, and ſpend themſelves, as animals do, in the production of leaves and fruit, and ſo become weaker than at other times of the year; their cavities and pores being then turgid with juices, or ſap, which, the trees being felled at that time, ſtill remain in the pores, having no way of being otherwiſe ſpent; and there they putrefy, not only leaving the tree full of thoſe cavities, which render the timber weak, but breeding a worm, as both *Pliny* and *Evelyn* do teſtify, that will ſo exceedingly damage it, as to become altogether unfit for heavy incumbrances, and other uſes that require ſtrength: All timber, felled at this ſeaſon of the year, whether the juices putrefy, or otherwiſe evaporate or dry away, is not only ſubject to rift and gape, but it will ſhrink ſo conſiderably, that a piece of ſuch timber, of a foot ſquare, will uſually ſhrink in breadth ¾ of an inch; than which, ſays *Vegetius*, nothing is more pernicious, if uſed for the building of ſhips; to which *Julius Cæſar* adds, that tho' ſhips may be made of ſuch moiſt timber, felled in the ſpring, yet they will certainly be ſluggs, and not near ſo good ſailers as ſhips made of timber felled later in the year: In all which circumſtances moſt of the ancients do ſo very well agree, that none of them adviſe the felling of timber for any uſe, before autumn at ſooneſt; others, not till the trees have borne their fruit, which, ſays *Theophraſtus*, muſt always be proportionably later, as their fruits are ripe, later in the year; others again, not till mid-winter; not till *November*, ſays *Palladius*; nay, not till the winter-ſolſtice according to *Cato*; and then too in the decreaſe or wane of the moon, between the 15th and 23d of her age, ſays *Vegetius*, or rather, according to *Columella*, between the 20th of the new-moon: In general, ſays *Theophraſtus*, the oak muſt be felled very late in the winter; not till *December*, as the emperor *Conſtantine Pogonatus* poſitively aſſerts, the moon too being then under the earth, as it is for the moſt part in the day-time, in the firſt part of its decreaſe; and the felling of oak within that compaſs of time, they call *Tempeſtiva Cæſura*, felling of timber in ſeaſon; and they all unanimouſly pronounce, that if it be thus felled, it will neither ſhrink, warp, cleave, nor decay in many years, it being tough as horn, and the whole tree in a manner, as *Theophraſtus* aſſerts, as hard and firm as the heart, with whom Mr. *Evelyn* agrees; if you do not fell oak, ſays he, till the ſap is at reſt, as it commonly is about *November* and *December*, after the froſt has well nipped them; the very ſaplings, thus cut, will continue without decaying, as long as the heart of the tree: And the reaſon of this is briefly given by *Vitruvius*, *quia aeris hyberni vis comprimit & conſolidat arbores*, becauſe the winter air doth cloſe the pores, and ſo conſequently conſolidates the trees; by which means, the oak, as he and *Pliny* both expreſs it, will acquire a ſort of eternity in its duration; and much more ſo, if it be barked in the ſpring, and left ſtanding all the ſummer, expoſed to the ſun and wind, as is uſual in *Staffordſhire* and the adjacent countries; whereby they find the trunks of their trees ſo dried and hardened, that the ſappy part, in a manner becomes as firm and durable as the heart itſelf: And tho' this manner of barking and felling of timber were unknown to the ancients, as perhaps it is to all the world beſides, except theſe few counties, yet they ſeem not unacquainted with the reaſonableneſs of the practice: *Vitruvius* prefers the timber on the ſouth-ſide the *Appenine* (where it winds about, and encloſes *Tuſcany* and *Campania*, and ſtrongly reflects the conſtant heat of the ſun upon it, as it were from a concave) incomparably before that, which grows on the north-ſide of the ſame hill, in the ſhady moiſt grounds; and his reaſon is, that the ſun does not only exhale the ſuperfluous moiſture of the earth, whence the trees are ſupplied in ſuch ſhady places with too great a quantity, but in great meaſure the remaining juices of the trees themſelves, after the production of leaves and fruits, rendring the timber of them more cloſe, ſubſtantial, and durable; which certainly would be done much more effectually, if the bark were taken off in the ſpring of the year, as in *Staffordſhire*, where the people uſe this method for their timber, tho' but for private uſes; much more ſo in ſhip-building, a thing of ſo public a concern, where tough and ſolid timber is much more neceſſary than in ordinary buildings: It is true, there is an act of parliament, 1 Jac. I. Chap. 22. which forbids the felling of timber for ordinary uſes, in conſideration of the tan, at any other time than between the firſt of *April* and the laſt of *June*, when the ſap is up, and the bark will run; to which it is readily anſwered, that poſſibly the legiſlators did not conſider, that the bark might be taken off in the ſpring, and the tree live and flouriſh all the enſuing winter; ſo that tho' the tree be not felled till the winter ſolſtice, or *January* following, yet the tanner is not at all defeated of his tan, but has it in due ſeaſon; and in that very act of parliament there was an exception of timber to be uſed in ſhip-building, which might be felled in winter, or at any other time: It is true indeed, that the barking and peeling of ſtanding-trees is ſomewhat more troubleſome, and therefore more chargeable than when they are proſtrate; and that it is likely, people have therefore uſually felled their timber, as well for ſhipping as other uſes, in the ſpring of the year, for the ſake of the more eaſy and cheap barking of it, rather than any thing elſe; it is alſo true, that timber is harder to fell in winter, it being ſo compact and firm, that the ax will not make ſuch impreſſion on it, as it doth in the ſpring, which will a little encreaſe the price of the felling, and its ſawing afterwards; but how inconſiderable theſe things are in compariſon of the great advantage of this manner of felling is ſelf-evident: The greateſt objection that can be urged againſt this practice is, that if the timber be not felled till mid-winter, or *January*, in the ſouth, where it grows in coppices and woods, they cannot perhaps incloſe their young ſprigs ſo ſoon as ſome may imagine needful, and therefore they will be backward to fell their timber at that ſeaſon; to which it is anſwered, that the timber ſo felled in woods or coppices may be eaſily carried off before the ſecond ſpring, and ſo the prejudice be ſmall; but what will quite remove this inconſiderable difficulty, is, that perhaps it may be expedient, that no timber whatſoever, growing in woods or coppices, be at all bought for the king's yards, becauſe that timber growing in ſuch ſhady places, and ſo fenced from the ſun and wind, as timber in woods for the moſt part is, cannot be ſo good as that which comes from an expoſed ſituation, ſuch as it uſually hath in foreſts, parks, hedge-rows, and open fields; where at leaſt it is indifferent, if not better for the proprietor, that it be felled in winter, when the graſs and corn are off the fields, than in the ſpring itſelf; and the officers deſigned for that purpoſe may buy all their timber under the condition of its being felled in winter, after the bark hath been taken off in the ſpring in due time.

The Jamaica Pepper-tree; *by Dr.* Hans Sloane. Phil. Tranſ. N° 192. p. 462.

THE *Myrtus arborea, foliis laurinis, aromatica pimienta*, or *Jamaica* pepper-tree, hath a trunk as thick as a man's thigh, riſing ſtreight up about 30 foot high, covered with a very ſmooth ſkin of a grey colour, and branching out on every ſide, with the extremities of its twigs ſet with leaves of ſeveral ſizes; the largeſt being four or five inches long, and two or three inches broad in the middle where broadeſt, decreaſing to both extremities, and ending in a point; they are ſmooth, thin, and ſhining, without inciſures, and of a deep green colour, and ſtanding on long footſtalks; when bruiſed, they are very fragrant, and in all things reſemble the leaves of a bay-tree; the ends of the twigs are branched into bunches of flowers, each footſtalk ſuſtaining a flower conſiſting of four herbaceous, or pale green *Petala*, bent back, or reflected downwards, within which are many *Stamina* of the ſame colour; to theſe ſucceed a bunch of crowned or umbilicated berries (the crown conſiſting of four ſmall leaves) bigger, when ripe, than juniper-berries; at firſt, when ſmall, they are greeniſh, but when ripe, they are black, ſmooth, and ſhining, containing, in a moiſt, green, and aromatic biting pulp, two large *Acini* or ſeeds, ſeparated by a membrane lying between them, each of which is an hemiſphere, and both together form a globe; whence *Cluſius* makes it one ſeed diviſible into two parts: This tree grows on all the hilly parts of *Jamaica*, but chiefly in the north thereof; it flowers in *June*, *July*, and *Auguſt*, but in ſeveral places ſooner or later, according to their ſituation, and the different ſeaſons for rain; and after it flowers, the fruit ſoon ripens; but it is to be obſerved, that in cleared open grounds, it is ſooner ripe than in thick woods: There is no great difficulty in the curing or preſerving of this fruit for uſe; it is generally done by the *Negroes*, who climb the trees, and pull off the twigs with the unripe green fruit, and afterwards carefully ſeparate the fruit from the twigs, leaves, and ripe berries; after which, they expoſe them to the ſun for ſeveral days, ſpreading them thin on cloths, and turning them at intervals, and carefully avoiding the dews, which are there very great; by this means they become a little ſhriveled and dry, and from a green change to a brown colour, and then they are fit for the market; they are of different ſizes, but generally of the bigneſs of black pepper, ſometimes reſembling cloves, juniper-berries, cinnamon, and pepper in ſmell and taſte, or rather having a peculiar mixed ſmell, ſomewhat a-kin to them all, whence the name of *All-Spice*: The ripe berries are very carefully ſeparated from thoſe to be cured, becauſe their moiſt and plentiful pulp renders them unfit for cure; whence, theſe berries coming always unripe and dried into *Europe*, naturaliſts have thought them to be *fructu umbilicato Sicco*; the ſmaller and the more fragrant they are, they are accounted the better: This fruit, diſtilled with water *per veſicam*, yields a very odoriferous chemical oil, which ſinks to the bottom of water, like oil of cloves; it may deſervedly be accounted the beſt and moſt temperate, the mildeſt and moſt innocent of common ſpices, and fit to come into greater uſe, and gain more ground, than it hath done yet, of the *Eaſt-India* commodities of this kind; all which it far ſurpaſſes, in promoting digeſtion, attenuating viſcidities, moderately heating and ſtrengthening the ſtomach, expelling wind, and doing thoſe friendly offices to the bowels, we generally expect from ſpices: It is now commonly ſold by druggiſts for *Carpobalſamum*, which Dr. *Sloane* ſuppoſes to be owing to *Hernandez*, who ſays it may be its *Succedaneum*; but it is not that fruit, but ſeems more fragrant and leſs aſtringent and balſamic than it; *Cluſius* ſays, it cures a ſtinking breath, if chewed; *John de Barrius* tells us, it is one of the ingredients in chocolate in *New Spain*; it has been taken by *Cluſius* for *Pliny's Caryophyllon*, and by others for *Amomum*; but it is not likely that it was known to the ancients, as not growing in the *Eaſt-* but *Weſt-Indies*.

The wild Cinnamon-tree; *by Dr.* Hans Sloane. Phil. Tranſ. N° 192. p. 465.

ARbor baccifera, laurifolia, aromatica, fructu viridi calyculat ramoſo, or the wild cinnamon-tree, commonly, but falſely, called *Cortex Winteranus*, hath a trunk about the thickneſs of a man's thigh, growing to about 20 or 30 foot high, with many branches and twigs hanging down from it, forming a very beautiful top; the bark conſiſts of two parts, one external, and the other internal; the former is as thin as a milled ſhilling, of a whitiſh aſh or grey colour, with ſome whiter ſpots ſprinkled here and there upon it, and ſeveral ſhallow furrows of a darker colour, running variouſly thro' it, which make it rough; it is of an aromatic taſte: The internal bark is much thicker than cinnamon, being as thick as a milled crown-piece, and ſmooth, and of a whiter colour than the external, and of a much more biting and aromatic taſte, ſomething like that of cloves, and not glutinous like that of cinnamon, but dry and crumbling between the teeth: The leaves come out near the ends of the twigs, without any order, ſtanding on footſtalks an inch long; they are each of them two inches in length, and one inch broad near the end, where they are broadiſh and roundiſh, being narrow at the beginning, from whence they encreaſe in breadth to near the extremity; they are of a yellowiſh green colour, ſhining and ſmooth, and without inciſures about the edges, and ſomewhat reſembling the leaves of bay, or *Lauro-ceraſus:* The ends of the twigs are branched into bunches of flowers, ſtanding ſomething like *Umbellæ*, each of which hath a footſtalk, on whoſe top is a calyx, conſiſting of ſome ſmall leaves, in which five ſcarlet or purple *Petala* do ſtand, and within which is a large *Stylus*; to theſe ſucceed ſo many calyculated berries, of the bigneſs of a large pea, roundiſh and green, and containing a mucilaginous pale-green, and thin pulp, and four black ſhining *Acini*, or ſeeds, of an irregular figure: All the parts of the tree, when freſh, are very hot, aromatic and biting to the taſte, ſomething like cloves: It grows in the low-lands or *Savannah* woods, and very frequently on each ſide of the road between *Paſſage Fort*, and the town of St. *Jago de la Vega*, in *Jamaica*, as alſo in *Antegoa*, and the other *Caribbee* iſlands: The bark of this tree is what is chiefly in uſe, both in the plantations of the *Engliſh* and in *Europe*; and it is eaſily cured, by only cutting off the bark, and ſuffering it to dry in the ſhade: The more ordinary ſort of people uſe it in the *Weſt Indies* inſtead of all other ſpices, being thought very good to correct the immoderate humidities of the ſtomach, help digeſtion, expel wind, &c. It is there as well as in *Europe* thought to be a very good remedy againſt the ſcurvy, and to cleanſe and invigorate the blood, being uſed for thoſe purpoſes by *London* druggiſts and apothecaries, under the name of *Cortex Winteranus*, which it is not, but it may very well ſupply its place; it is in the *Weſt Indies*, mixt and given with ſteel, and other medicines; but if the patient be of a hot conſtitution, it does more harm than good, it being very warm: If rum, which is a vinous ſpirit drawn from molaſſes, or bad ſugar fermented with water, be mixed with ſome of this bark, it loſes in part its loathſome empyreumatic ſmell: This bark, if mixed with water, and diſtilled *per Veſicam*, yields an aromatic oil, ſinking to the bottom of the water like oil of cloves.

The Circulation of the Watry Vapours *and the origin of* Springs; *by M.* Edm. Halley. Phil. Tranſ. N° 192. p. 468.

IF a particle of water were expanded into a ſhell or bubble, ſo as to become ten times as big in diameter as when it was water, ſuch a particle would become ſpecifically lighter than air, and riſe as long as that flatus, or warm ſpirit, that firſt ſeparated it from the maſs of water, continued to diſtend it to the ſame degree; but that warmth decreaſing and the air growing cooler, and withal ſpecifically lighter, the vapours will conſequently ſtop in a certain region of the air, or elſe deſcend; which may happen on ſeveral accounts, as will appear anon: Yet Mr. *Halley* does not pretend that this is the only principle of the riſe of vapours, and that there may not be a certain ſort of matter, whoſe conatus may be contrary to that of gravity, as is evident in vegetation, wherein the tendency of the ſprouts is directly upwards, or againſt the perpendicular: But whatever be the true cauſe, it is certain in fact, that warmth does ſeparate the particles of water, and emit them with a velocity proportionable to the intenſeneſs of the heat; as is evident in the ſteam of a boiling cauldron, wherein likewiſe the velocity of the aſcent of the vapours does viſibly decreaſe, till they diſappear: Vapours being thus raiſed by warmth, let us in the firſt place ſuppoſe, that the whole ſurface of this globe were all water to a great depth, or rather, that the whole body of the earth were water, and that the ſun had his diurnal courſe about it; it would follow that the air would of itſelf imbibe a certain quantity of aqueous vapours, and retain them, like ſalts diſſolved in water; that the ſun warming the air, and raiſing more plentiful vapours from the water in the day-time, the air would ſuſtain a greater proportion of them, as warm water will hold more diſſolved ſalts, which, upon the abſence of the ſun in the nights, would be all again diſcharged in dews, analogous to the precipitation of ſalts on the cooling of the liquors; nor is it to be thought, that in ſuch a caſe there would be any diverſity of weather, other than what would be periodical, and every year alike, the ſeveral mixtures of terreſtrial, ſaline heterogeneous vapours being quite taken away; which, as they are variouſly compounded, and brought by the winds, ſeem to be the cauſes of thoſe various ſeaſons, we now obſerve: In this caſe, the regions of air, every where at the ſame height, would be equally repleniſhed with the proportion of water it would contain, regard being only to be had to the different degree of warmth, from the nearneſs or diſtance of the ſun; and an eternal eaſt-wind would blow all round the globe, inclining only to the ſame ſide of the eaſt, as the latitude does from the *Equator*, as is obſerved in the ocean between the *Tropics:* In the next place let us ſuppoſe this ocean interſperſed with wide and ſpacious tracts of land, with high ridges of mountains, as the *Pyrenean*, *Alps*, *Appenine* and *Carpathian* in *Europe*; *Taurus*, *Caucaſus*, *Imaus*, and ſeveral others in *Aſia*; *Atlas* and the *Montes Lunæ*, with other unknown ridges in *Africa*, whence the *Nile*, *Niger* and the *Zaire* ariſe; and in *America*, the *Andes*, and the *Apalatean* mountains; each of which far ſurpaſs the uſual height to which the aqueous vapours of themſelves aſcend, and on the tops of which the air is ſo cold, and rarified, as to retain but a ſmall part of thoſe vapours brought thither by the winds: Thoſe vapours therefore, that are raiſed copiouſly in the ſea, and by the winds carried over the low-lands to thoſe ridges of mountains, are there compelled by the ſtream of the air to mount up with it to the tops of the mountains, where the water preſently precipitates, gleeting down by the crevices of the ſtones; and part of the vapours entring into the caverns of the hills, they are collected, as in an alembic, into the baſons of ſtone they find there, which being once filled, all the overplus of water, that comes thither, runs over at the loweſt place, and breaking out by the ſides of the hills, forms ſingle ſprings; many of theſe running down the vallies or guts between the ridges of hills, and coming to unite, form little rivulets or brooks; and many of theſe again, meeting in one common valley, and gaining the plains, and growing leſs rapid, become a river; and of theſe again ſeveral united in one common channel, make ſuch ſtreams, as the *Rhine*, *Rhone* and the *Danube*; which latter, one would hardly think to be the collection of the water condenſed from vapours, if we did not conſider how vaſt a tract that river drains, and that it is the aggregate of all thoſe ſprings, which break out on the ſouth-ſide of the *Carpathian* mountains, and on the north-ſide of the immenſe ridge of the *Alps*, which is one continued chain of mountains from *Switzerland* to the *Black Sea*; and it may generally paſs for a rule, that the magnitude of a river, or the quantity of water it diſcharges, is proportionable to the length and height of the ridges, from whence its fountains ariſe: Thus one part of the vapours, which is blown upon the land, returns by the rivers into the ſea, from whence they came: Another part is by the cool of the night made to fall again by dews, or elſe by rains, into the ſea, before it reaches the land; which is by far the greater part of the whole quantity of vapours, becauſe of the great extent of the ocean; and this is the reaſon, why rivers do not return into the *Mediterranean* ſo much, as is raiſed in vapour: A third part falls on the low-lands, where it becomes the *Pabulum* of plants, from which it is exhaled again in vapour by the action of the ſun, and either carried by the winds to the ſea, to fall there in rain or dew; or elſe to the mountains to be there turned into ſprings; and tho' this does not immediately happen, yet after ſeveral viciſſitudes of riſing in vapour and falling in rain or dews, each particle of the water is at length returned to the ſea, from whence it came: Add to this, that the rain-water, after the earth is fully ſated with moiſture, does by the vallies find its way into the rivers, and ſo is compendiouſly ſent back into the ſea: In this manner is the circulation performed; and this hypotheſis ſeems more reaſonable than that, which derives all ſprings from rain-waters, which yet are perpetual, and without diminution, even when no rain falls for a long ſpace of time; or than that, which derives them from a filtration of the ſea-waters thro' certain imaginary tubes or paſſages within the earth, wherein they loſe their ſaltneſs; but this latter hypotheſis, beſides many others, labours under this principal abſurdity, that the largeſt rivers have their moſt copious fountains fartheſt from the ſea: This, if we may allow of final cauſes, ſeems to be the deſign of the hills, to ſerve as alembics to diſtil freſh water for the uſe of man and beaſt, and their heights to give a deſcent to thoſe ſtreams, to run down gently, like ſo many veins of the macrocoſm, to be the more beneficial to the creation: Now this theory of ſprings is not a bare hypotheſis, but founded on experience, which Mr. *Halley* had gained at St. *Helena*; where, in the night-time, only on the tops of the hills, about 800 yards above the ſea, there was ſo ſtrange a condenſation, or rather precipitation of the vapours, that they proved a great hindrance to him in his celeſtial obſervations; for in a clear ſky, the dew would fall ſo faſt as to cover, every half quarter of an hour, his glaſſes with little drops, ſo that he was obliged to wipe them often; and his paper would be ſo wet that it would not bear ink.

The Modern Theory of Generation; *by Dr.* Geo. Garden. Phil. Tranſ. N° 192. p. 474.

UPON comparing the obſervations and diſcoveries of Dr. *Harvey*, Sig. *Malpighi*, *De Graaff* and M. *Lewenhoeck* together; Dr. *Garden* concludes, that the following three things ſeem very probable. 1. That animals are *ex Animalculo*. 2. That the *Animalcules* are originally in the male ſeed and not in that of the female. 3. That they can never come forward, nor be formed into animals of their reſpective kinds, without the *Ova* in the female: The firſt of theſe Dr. *Garden* argues from theſe three obſervations. 1. That ſomething has often been obſerved by *Malpighi* in the *Cicatricula* of an egg before incubation, like the rudiments of an animal, in form of a tadpole. 2. From the ſudden appearance and diſplaying of all the parts after incubation, it ſeems probable that they are not then actually formed out of a fluid, but that the *Stamina* of them have been formerly there exiſtent, and are now expanded; the firſt part of the chick, which is diſcovered with the naked eye, is the *Punctum Saliens*, and that not till three days and nights of incubation are paſt; and then on the fifth day the rudiments of the head and body do appear: This made Dr. *Harvey* conclude, that the blood had a being before any other part of the body, and that from it all the organs of the fœtus were both formed and nouriſhed; but by *Malpighi's* obſervations it appears, that the parts are then only ſo far extended, as to be made viſible to the naked eye, and that they were actually exiſtent before, and diſcernible by glaſſes: After an incubation of 30 hours, we ſee the head, the eyes, and the *Carina*, with the *Vertebræ*, diſtinct, and the heart; after 40 hours its pulſe is viſible, and all the other parts are more diſtinct, which cannot be diſcerned by the naked eye before the beginning of the fifth day; from whence, it ſeems very probable, that even the ſo early diſcovery of thoſe parts of the fœtus by the microſcope, is not the diſcerning of thoſe parts newly formed, but only are dilated and extended, by receiving of nutriment from the *Colliquamentum*; ſo that they ſeem all to be actually exiſtent before the incubation of the hen: And what *Swammerdam* hath diſcovered, in the transformation of inſects, gives no ſmall light to this; ſince he makes it appear, that in thoſe large *Eruca*'s, which feed upon cabbage, if taken about the time they retire to be transformed into *Aurelia*'s, and plunged often in warm water, to make a rupture of the outer ſkin; you will diſcern, thro' the tranſparency of their ſecond membrane, all the parts of the butterfly, as the trunk, wings, feelers, *&c.* folded up; but, that after the *Eruca* is changed into an *Aurelia*, none of theſe parts can be diſcerned, being ſo much drenched with moiſture, tho' they be there actually formed: Another conſideration is from the analogy, which we may ſuppoſe between plants and animals; all vegetables we ſee proceed from little plants, the ſeeds of vegetables being no other but little plants of the ſame kind, folded up in coats and membranes; and from hence we may probably conjecture, that ſo curiouſly an organized creature, as an animal, is not the ſudden product of a fluid or *Colliquamentum*, but does much rather proceed from an *Animalcule* of the ſame kind, and has all its little members folded up according to their ſeveral joints and plicatures, which are afterwards enlarged and diſtended, as we ſee in plants: Now tho' this conſideration alone may ſeem not to have much weight, yet joined to the two former, they mutually ſtrengthen each other: And indeed all the laws of motion which are hitherto diſcovered, can give but a very lame account of the formation of a plant or animal; we ſee how wretchedly *Des Cartes* acquits himſelf, when he began to apply them to this ſubject; they are formed by laws yet unknown to mankind; and it ſeems moſt probable, that the *Stamina* of all the plants and animals, that have been, or ever ſhall be in the world, have been formed at firſt by the Almighty Creator within the firſt of each reſpective kind; and he who conſiders the nature of viſion, that it does not give us the true magnitude, but the proportion of things; and that which ſeems to our naked eye but a point, may truly be made up of as many parts, as ſeem to us to be in the whole univerſe, will not think this an abſurd or impoſſible thing.

The ſecond point, which later diſcoveries have made probable, is, that theſe *Animalcules* are originally, in the ſeed of the male and not in the female; for, 1. There are obſerved innumerable *Animalcula* in the ſeed of the male of all animals; M. *Leewenhoeck* hath made this ſo evident, that there ſeems little room to doubt thereof. 2. We obſerve the rudiments of a fœtus in eggs which have been fecundated by the male; but no ſuch thing is to be ſeen in thoſe which are not ſo impregnated;

nated; and *Malpighi*, in his obſervations, makes it very probable, that theſe rudiments proceed originally from the male, and not the female. 3. The reſemblance between the rudiments of the fœtus *in Ovo*, both before and after incubation, and the *Animalcule*, makes it very probable, that they are one and the ſame; the ſame ſhape and figure, which M. *Leewenhoeck* gives us of the *Animalcule*, *Malpighi* likewiſe gives of the rudiments of the fœtus, both before and after incubation; yea, and even the fœtus's of animals do appear ſo at firſt to the naked eye; whence Dr. *Harvey* acknowledges, that all animals, even the moſt perfect, are produced of a worm. 4. This gives a rational account of many fœtus's at one birth, eſpecially that of the Counteſs of *Holland*; and how, at leaſt, a whole cluſter of eggs in a hen are fecundated by one coition of the male. 5. This gives a new light as it were, to the firſt prophecy concerning the *Meſſiah*, that *the ſeed of the woman ſhall bruiſe the head of the ſerpent*; all the reſt of mankind being thus moſt properly and truly the ſeed of the man. 6. The analogy already, which we may rationally ſuppoſe between the manner of the propagation of plants and animals, does likewiſe make this probable: Every herb and tree bears its ſeed after its kind, which ſeed is nothing elſe but a little plant of that kind, which being thrown into the earth, as into an *Uterus*, ſpreads forth its roots, and receives thence its nouriſhment; but hath its form within itſelf; and we may rationally conjecture ſome ſuch analogy in the propagation of animals.

The third particular, which later diſcoveries make probable, is, that animals cannot be formed of theſe *Animalcules* without the *Ova* in females, which are neceſſary for ſupplying them with proper nutriment; and this is evinced from the following conſiderations. 1. It is probable, that an *Animalcule* cannot come forward, if it do not fall into a proper *Nidus*; this we ſee in the *Cicatricula* in eggs; for tho' a million of them ſhould fall into an egg, none of them would come forward, but what were in the centre of the *Cicatricula*; and perhaps the *Nidus* neceſſary for their formation is ſo proportioned to their bulk, that it can hardly contain more than one *Animalcule*; and this may be the reaſon, why there are ſo few monſters: This we ſee is abſolutely neceſſary in the oviparous kinds; and the only difference, between them and the viviparous, ſeems to be this, that in the latter, the *Ova* are properly nothing but the *Cicatricula* with its *Colliquamentum*, ſo that the fœtus muſt

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ſpread forth its roots into the *Uterus*, to receive its nouriſhment; but the eggs in the oviparous may be properly termed an *Uterus*, in relation to the *Fœtus*; for they contain not only the *Cicatricula*, with its *Amnion* and the *Colliquamentum*, which latter is the immediate nouriſhment of the fœtus, but alſo the materials, which are to be converted into that *Colliquamentum*; ſo that the *Fœtus* ſpreads forth its roots no farther than into the white and yolk of the egg, from whence it derives all its nouriſhment: Now that an *Animalcule* cannot come forward without ſome ſuch proper *Nidus*, will not be denied; for if there were nothing needful, but their being thrown into the *Uterus*, we do not ſee why many hundreds of them ſhould not come forward at once, at leaſt whilſt ſcattered in ſo large a field. 2. That this *Cicatricula* is not originally in the *Uterus*, ſeems evident from the frequent conceptions, which have been found without the *Uterus*; ſuch as the child, that continued 26 years in the woman of *Tholouſe*'s belly; and the little *Fœtus* found in the *Abdomen* of *Mad. de* St. *Mere*, together with the teſticle torn, and full of clotted blood; ſuch alſo ſeems to be the *Fœtus* in the *Abdomen* of the woman of *Copenhagen*; all whoſe members were eaſily to be felt thro' the ſkin of the belly, and which ſhe had carried in her belly for four years: Now granting once the neceſſity of a proper *Nidus*, for the formation of an *Animalcule* into an animal of its reſpective kind; theſe obſervations make it probable, that the *Teſtes* are the *Ovaria* appropriated for that uſe; for tho' the *Animalcules* coming thither in ſuch caſes may ſeem to be extraordinary, and that uſually the impregnation is *in Utero*; yet it may be collected from thence, that the *Cicatriculæ* or *Ova* to be impregnated, are in the *Teſtes* of the female; for if it were not ſo, the accidental coming of *Animalcules* thither could not make them more forward than in any other part of the body, ſince they cannot be formed and nouriſhed without a proper *Nidus*. 3. It is acknowledged, that the *Fœtus in Utero*, for ſome conſiderable time after conception, hath no connection with the womb; that it ſits wholly looſe to it, and is perfectly a little round egg with the *Fœtus* in the middle, which ſends forth its umbilical veſſels by degrees, and at laſt lays hold on the *Uterus*: Now from hence it ſeems evident, that the *Cicatricula*, which is the fountain of the *Animalcule*'s nouriſhment, does not ſprout from the *Uterus*, but hath its origin elſewhere, and falls in thither, as into a fit ſoil, from whence it may draw nutriment for the growth of the *Fœtus*;

Fœtus; elſe it cannot be eaſily imagined, how it ſhould not have an immediate connection with the *Uterus*, from the time of conception: If you join all theſe three conſiderations together; *viz.* that an *Animalcula* cannot come forward without a proper *Nidus* or *Cicatricula*; that there have been frequent *Fœtus*'s found withoutſide of the womb; and that they have no adheſion to the *Uterus*, for a conſiderable time after conception; theſe things ſeem to make it evident, that animals cannot be formed from *Animalcules* without the *Ova* in females: To all this, Dr. *Garden* ſubjoins the propoſal of an *Experimentum Crucis*, which may ſeem to determine, whether the *Teſtes* in females be truly the *Ovaria*; which is to open the *Abdomen* of the females of ſome kinds, and cut out their teſticles; and this will determine, whether they be abſolutely neceſſary to the formation of animals: There are ſome difficulties propoſed againſt this conjecture, which the Doctor thinks may be eaſily ſolved; ſome object the diſtance between the *Tubæ* or *Cornua Uteri*, and the teſticles; but to this, *Swammerdam* and others oppoſe the like diſtance between the *Infundibulum* in hens and frogs, and the ovary; and yet it cannot be denied, that the eggs are tranſmitted thro' this into the *Uterus*; and beſides, *de Graaf* and others, have by repeated obſervations found, that the *Cornua Uteri* do, at certain times after conception, embrace the *Teſtes* on both ſides the *Uterus*: In the ſecond place, they object the great diſproportion between the pretended eggs in the ovary, and the aperture of the *Tubæ*, or *Cornua Uteri*; the former being a great deal bigger than the latter; but both *de Graaf* and *Malpighi* have cleared that matter, by making appear, that theſe bladders in the ovary are not the *Ova*, but ſerve to form the glands wherein the *Ova* are produced, which break thro' a ſmall *Papilla*, opening in the gland, which bears a proportion to the aperture of the tube. 3. They object the difficulty of conceiving, how theſe eggs ſhould be impregnated by the ſeed of the male, both becauſe there is no connexion between the *Tubæ* and the ovary for its tranſmiſſion, and becauſe Dr. *Harvey* could never diſcover any thing thereof in the *Uterus*; as to this laſt difficulty, M. *Leewenhoeck* hath cleared it, by the diſcovery of innumerable *Animalcules* of the ſeed of the male in the *Cornua* of the *Uterus*, and thoſe living a conſiderable time after coition: As to the former, we may either ſuppoſe, that there is ſuch an inflation of the *Tubæ* or *Cornua Uteri* in the time of coition, as makes them embrace the *Ovaria*, and ſuch an approach of the *Uterus* and its *Cornua*, as that it may eaſily tranſmit the ſeed into the ovary; or elſe, that the *Ova* are impregnated by the *Animalcules* after they deſcend into the *Uterus*, and not in the ovary; the former ſeems probable for this reaſon, that at leaſt a whole cluſter of eggs in a hen will be impregnated by one tread of the cock; now this impregnation ſeems to be in the vitellary, and not in the *Uterus*, as the eggs paſs along from day to day; for it can hardly be ſuppoſed, that the *Animalcules* ſhould ſubſiſt ſo long, being ſcattered looſely in the *Uterus*, as to wait there many days for the fecundation of the eggs, as they paſs along; the latter conjecture hath this to ſtrengthen it, that the *Animalcules* are found to live a conſiderable time in the *Uterus*; and that if they ſhould impregnate the *Ova* in the ovary itſelf, the *Fœtus* would encreaſe ſo faſt, that the *Ova* could not paſs thro' the *Tubæ Uteri*, but would either burſt the ovary, or fall down into the *Abdomen* from the orifices of the *Tubæ*; and that from hence proceed thoſe extraordinary conceptions in the *Abdomen* withoutſide the *Uterus*: But M. *Leewenhoeck*, to weaken this conſideration about the conception's being like unto an *Ovum* in the womb, propoſes a parallel between theſe *Animalcules* and inſects, and inſinuates, that as the latter caſt their ſkins, and appear of another ſhape, ſo the other, which at firſt ſeem like tadpoles, may caſt their outer ſkin, and then become round, which may be the cauſe of the round figure of the conception in the womb: To this it may be replied, that according to M. *Leewenhoeck*'s own ſentiment, the *Animalcules* cannot come forward, if they do not find the *Punctum* or proper place for their nouriſhment, to which it ſeems they muſt have ſome adheſion: Now the conception in the viviparous kind is not faſtened to the womb for many days, nor adheres to any point thereof; ſo that it ſeems this roundiſh body is not the *Animalcula* thus changed, after having caſt an outer ſkin, but is rather the *Cicatricula* or little egg, into which the *Animalcula* hath entred, as into its *Punctum*, or place of nouriſhment; elſe it is not eaſy to account for, why they ſhould not be adhering to the womb from the firſt conception, or why many hundreds of them are not conceived and formed together.

An Injection of Mercury *into the* Blood, *and its Effects on the* Lungs; *by Dr.* Moulin. Phil. Tranſ. N° 192. p. 486.

UPON injecting into the jugular vein of a dog, about half an ounce of crude mercury, ſoon after, he was obſerved to have a dry ſhort cough, which by intervals ſeized him;

about two days after that, he was affected with a great difficulty of breathing, and made a noiſe like a broken winded horſe; there was no tumour about the root of his tongue, nor any ſwelling in the maxillary or parotid glands, neither was he obſerved to drivel, tho' he was ordered warm broth in hopes of a ſalivation; the fourth day after the injection of the mercury he died, being for two days before ſo troubled with an *Orthopnœa*, that he could ſleep only, when he leaned his head againſt ſomething: Upon opening him, there was found about a pint of bloody *Serum* in the *Thorax*; the outſide of the lungs was bliſtered in moſt places, ſome of which were larger than a rouncival-pea, others were ſmaller; but moſt of them contained mercurial globules, to be ſeen even without opening thro' the outward integument; ſeveral of them were found broken, and upon a little preſſure, the mercury was obſerved to run out, and with it a little ſanies; but upon a pretty ſtrong preſſure, a great quantity of that ſanies iſſued out: Upon opening the right ventricle of the heart, ſome particles of quickſilver were found in the very middle of the coagulated blood lodged there; and alſo in that contained in the *Arteria Pulmonalis*: The blood was obſerved to be coagulated after a very different manner from what it is ſeen at any other time, by the various methods of doing it, in the interſtices of the *Columnæ* of the aboveſaid ventricle, and in it a greater quantity of quickſilver than any where elſe in the dog; this *Coagulum* was in the *Vertex* of the ventricle, adhering pretty cloſely to the *Columnæ* and *Parietes*: After opening the left ventricle, there was found a very tenacious blood, adhering firmly to the great valve, and reſembling in ſome meaſure a *Polypus*; in this ventricle no mercury was to be found, tho' diligently ſought for; whence it may appear, that the mercury paſſed no farther than the extremities of the *Arteria Pulmonalis*; whereby it cauſed the aforeſaid bliſters, and forced its way thro' the common coat of the lungs: Upon opening the *Aſpera Arteria* down to the very *Bronchiæ*, no mercury was to be ſeen, tho' carefully ſearched for. Each of the ſubdiviſions, as well as diviſions, of the *Bronchiæ* were filled with a ſanies, which, when waſhed away, globules of mercury were found in many places under the *Bronchiæ*, and upon examination, they proved to be in the *Arteria Pulmonalis*; theſe globules were preſſed backwards and forwards, and ſome of them got out at the holes made in the *Veſiculæ*, or bliſters above deſcribed.

From hence may appear the danger of uſing mercury in human bodies, ſo as to get into the maſs of blood, eſpecially into the lungs; becauſe they are of a lax, ſpongy texture, and want that briſk ſtrong motion, which the muſcles have in other parts, whereby they are enabled to force it along with the blood, in order to the raiſing a ſalivation: That mercury hath this effect on the human lungs, is plain from what we daily ſee in perſons, that have been often fluxed, who are afterwards obſerved to die of conſumptions, that will yield to no medicines.

The Time and Place of Cæſar's Deſcent *upon* Britain; *by Mr.* Edm. Halley. Phil. Tranſ. N° 193. p. 495.

THE authors, that mention this expedition with any circumſtances, are *Cæſar* in his commentaries *Lib.* 4. and *Dion Caſſius* in *Lib.* 39: It is certain, that this expedition of *Cæſar* was in the year of the Conſulate of *Pompey* and *Craſſus*, which was in the year of *Rome* 699, or the 55th before the vulgar Æra of Chriſt; and as to the time of the year, *Cæſar* ſays, that, *exiguâ parte æſtatis reliquâ*, he came over only with two legions, *viz.* the 7th and 10th, and all foot, in about 80 ſail of merchant-ſhips; 18 ſail, that were ordered to carry over the horſe, not being able to get out at the ſame time from another port, where they lay wind-bound: He ſays, that he arrived about the fourth hour of the day, *viz.* between 9 and 10 in the morning, on the coaſt of *Britain*; where he found the enemy, drawn up on the cliffs, ready to repel him; which place he thus deſcribes, *loci hæc erat natura, adeo montibus anguſtis mare continebatur, ut ex locis ſuperioribus in littus telum adjici poſſit*; by which the cliffs of *Dover*, and the *South-foreland* are juſtly deſcribed; and it could be no other land, ſeeing, he ſays, in the fifth book of his commentaries, *in Britanniam trajectum eſſe cognoverat circiter Millium paſſuum triginta a Continenti*: Here, he ſays, he came to anchor, and ſtayed till the 9th hour, or till about 3 or 4 in the afternoon, waiting till the whole fleet was come up; and in the mean time he called a council of war, and gave inſtructions to his officers, in what manner they were to make their deſcent, particularly in relation to the ſurf of the ſea, whoſe motion he calls *celerem atque inſtabilem*, quick and uneven: Then about 3 o'clock in the afternoon he weighed anchor, and having got the wind and tide with him, he ſailed about eight miles from the firſt place, and anchored againſt an open and plain ſhore; here he made his deſcent, and after relating the oppoſition that was made, and the means he uſed to get on ſhore, he informs us, that after he had been four days in *Britain*, the 18 ſhips with the horſe put to ſea, and were come within ſight of his camp, when a ſudden tempeſt aroſe, together with a contrary wind, ſo that ſome of the ſhips put back again, others were driven to the weſtward, not without great danger; and coming to anchor, they found they could not ride it out; ſo when night came on, they put off to ſea, and returned from whence they came; that very night it was full-moon, which makes the greateſt tides in the ocean; and they being ignorant thereof, their gallies, which were driven on ſhore, were filled by the tide, *&c.* Then he ſays, that the day of the autumnal equinox being at hand, after ſome days ſtay, wherein there paſſed no action, becauſe he kept cloſe in his camp by the ſhore, and not thinking it proper to ſtay till the winter came on, he returned into *Gallia*: The next year he made another expedition with five legions, and a good body of horſe; but there is little in the hiſtory thereof to our purpoſe, excepting that he ſays, he ſet ſail from the *Portus Icius* about ſun-ſet with a gentle S. W. wind, *leni africo profectus*; that about midnight it fell calm, and being carried away with the tide, by the time it was day, he found he had left *Britain* on the left; but then the tide turning, they fell to their oars, and by noon reached that part of the iſland, where he landed before, and came a-ſhore without oppoſition, and then he marched up into the country, leaving his ſhips at anchor in *littore molli & aperto.*

Dion Caſſius, ſpeaking of the firſt landing of *Cæſar*, ſays, ὀ μεντοι, ϗ ῆ ἐδει, προσεσχεν, that is, as Mr. *Halley* tranſlates it, *but he landed not where he intended*, becauſe the *Britons*, hearing of his coming, had poſſeſſed all the uſual places of landing, ἀκραν ȣ̃ν τινα προεχȣσαν περιπλευσας, ἑτερωσε παρεκομισθη, κἀνταυθα τȣς προσμιξαντας, οἱ ἐς τα τεναγη αποβαινοντι νικησας, ἐφθη της γης κρατησας; in Mr. *Halley's Engliſh*, *Wherefore doubling a certain head-land, he made to the ſhore on the other ſide, where he overcame thoſe, that ſkirmiſhed with him at the water's edge, and ſo got ſafe on land.*

From theſe *data*, *viz.* that it was in the year of the Conſulate of *Pompey* and *Craſſus*; that it was *exiguâ parte æſtatis reliquâ*, and four days before a full-moon, which fell out in the night-time; the time of this invaſion will be determined to a day; for, by the eclipſe of the moon, whereof *Druſus* made ſo good uſe, as to quiet a mutiny in the *Pannonian* army, upon the

news

news of the death of *Auguſtus*, it follows, that *Auguſtus* died in the year of Chriſt 14, which was reckoned 767 U. C. or building of *Rome*; and that this expedition was 68 years before, *viz.* in the 55th year before Chriſt; in which year the full-moon happened *Auguſt* 30th after midnight, or 31ſt in the morning before day; and the preceeding full-moon was *Auguſt* 1ſt, ſoon afternoon; ſo that this could not be the full moon mentioned, as happening in the day-time; nor that in the beginning of *July*, it being not 10 days after the ſummer-ſolſtice, when it would not have been ſaid, *exiguâ parte æſtatis reliquâ:* It follows therefore, that the full-moon ſpoken of was on *Auguſt* the 30th, at night; and that the landing in *Britain* was *Auguſt* 26th, in the afternoon, about a month before the autumnal equinox; which agrees with all the circumſtances of the ſtory in point of time.

As to the place; the high land and cliffs deſcribed, being allowed by all to be thoſe of *Dover*; it only remains to examine, whether the deſcent was made to the northward or ſouthward of the place where he firſt anchored; the *data* to determine this, are, firſt, that it was four days before the full-moon. 2. That that day, about 3 o'clock in the afternoon, the tide ran the ſame way he ſailed. 3. That a S. by E. moon makes high-water on all that coaſt, the flood coming from the ſouthward; hence it will follow, that that day it was high-water there about 8 o'clock in the morning, and conſequently low-water about 2, wherefore by 3 the tide of flood was well made up; and it is plain, that *Cæſar* went with it; and the flood ſetting to the northward, ſhews that the open plain ſhore, where he landed, was to the northward of the cliffs, and muſt be in the *Downs*; and this appears to be little leſs than demonſtration: A ſecond argument is drawn from the wind, wherewith he ſet out on his ſecond expedition, *viz.* S. W. as appears by the words, *leni Africo profectus*, with which the navigation of thoſe times would hardly permit a ſhip to ſail nearer the wind than 8 points, or a N. W. courſe; which would ſerve indeed to go into the *Downs*, but would by no means fetch the low land towards *Dungeneſs*, which is much about weſt from *Calais*, and not more than W. N. W. from *Boulogne*, if that be the *Portus Icius*, from which *Cæſar* ſet out: Whence it is evident, that if *Cæſar* was not bound more northerly than the *South-Foreland*, he could not have thought the *Africus*, or S. W. wind, proper for his paſſage, which was then intended for the place, where he firſt landed the preceeding year: To determine juſtly which was the *Portus Icius*, there are no ſufficient grounds; only *Ptolemy* calls the Promontory of *Calais* cliffs by the name of Ἰκιον ἀκρον, whence there is reaſon to conjecture, that the *Portus Icius* was very near thereto, and that it was either *Ambleteuſe* on one ſide, or *Calais* on the other: The ſame *Ptolemy* places Γισαρρίακον ἐπινειον in the ſame latitude with the Ἰκιον ἀκρον, but ſomething more to the eaſt; which ſeems to refute thoſe that have ſuppoſed the ancient port of *Geſſoriacum* to have been *Boulogne*; whereas, by *Ptolemy*'s poſition, it muſt be either *Dunkirk* or *Graveling*, but moſt probably the former, both by the diſtance from the Ἰκιον ἀκρον, being about 20 miles, or half a degree of longitude to the eaſt, or $\frac{2}{5}$ of the whole coaſt of *Flanders*, which he makes but a degree and a quarter from the *Acron Icion* to the mouth of the *Scheld*, which he calls *Oſtia Tabudæ*; as alſo, becauſe *Pliny*, *l.* 4. *c.* 16. ſpeaking of *Geſſoriacum*, ſays, the *Proximus Trajectus* into *Britain*, from hence, is 50 miles, which is too much, unleſs *Geſſoriacum* were ſomething more eaſterly than *Calais*: *Dion Caſſius* makes the diſtance between *France* and *Britain* 450 *Stadia*, or 56 miles, and ſays likewiſe it is the neareſt, το συντομωτατον: But this is in part corrected by the explication given in the itinerary of *Antoninus*, where the ſpace between *Geſſoriacum* and *Rutupium* is ſaid to be 450 *Stadia*, for this was the ordinary paſſage of the *Romans* into *Britain*; *Rutupium* being more northerly, and *Geſſoriacum* more eaſterly than the limits of *Cæſar*'s voyage; and conſequently the diſtance more than 30 miles, which *Cæſar* had obſerved; and an accurate ſurvey hath ſhewn the diſtance between land and land to be 26 *Engliſh* miles, or 28 $\frac{1}{2}$ *Roman* miles, which ſhews how near *Cæſar*'s eſtimate was to the truth: Another argument but not of equal force with the former, becauſe of the modernneſs of the author, who wrote above 150 years after, may be drawn from the words of *Dion Caſſius*, where he ſays, ἀκραν τινα προεχουσαν περιπλευσας ἑτερωσε παρεκομισθη, that after his firſt anchoring, he ſailed about a promontory to the place where he landed: Now there are no other promontories on all that coaſt, but the *South-Foreland* and *Dungeneſs*; the latter of which it could not be, becauſe *Cæſar* ſays he ſailed but 8 miles, and the *Neſs* itſelf is about 10 miles from the ſouth and neareſt end of the chalk-cliffs near the town of *Hithe*; and to have gone round that point to the other ſide, the diſtance muſt have been much greater; ſo that the Promontory, mentioned by *Dion*, muſt needs be the *South-Foreland*, and *Cæſar* muſt have anchored nearly over-againſt *Dover*; from whence ſailing 8 miles, he muſt double a head-land, and come to the *Downs*; which is ſuch a coaſt, as he deſcribes in one place by *apertum ac planum littus*, and in his fifth book by *molle ac apertum littus:* As to *Dion*'s words, εις τα τεναγη, tranſlated, *at the water's edge*; there is the authority of *Suidas* for ſo doing, who ſays, τεναγος, πελαγια ἰλυς, or the ſea mud, and is therefore properly the ouſe on the ſea-ſhore; and the etymologiſts derive it from τεγγω, *madefacio*, becauſe the waſh and breech of the ſea do always keep it wet; and this word τα τεναγη is uſed by *Polybius* for the ſea-ouſe; and in another place he ſpeaks of the difficulty of landing at the mouth of a river, δια τον τεναγωδη παροδον, becauſe of its ouſy acceſs; ſo that it is not to be doubted, that it ought to be rendered in this place, *ad vadum maris*, rather than *in paludibus:* And ſo this objection againſt the aſſertion, that *Cæſar* landed in the *Downs*, which is known to be a firm champaign country, without fens and moraſſes, will be removed.

The Ruſſian *Method of curing* Caſtoreum. Phil. Tranſ. N° 193. p. 501.

TAKE beaver-ſtones, and get the milk out of them as clean as you can; then ſet on the fire a ſkillet, or kettle of water, big enough to contain the quantity of ſtones you deſign to cure; let the water boil, and put into it half a ſhovel-full of clean wood-aſhes; then tie the ſtones together in pairs and put them into the water, and let them boil therein for half a quarter of an hour; then take ſome birch-bark, and lay it on the fire, and let the ſtones be well ſmoaked over it for the ſpace of an hour, until they are well dried in the ſmoak; then hang them up in a kitchen, or in the air, for a week or more, until they are perfectly dry and hard; after which, they may be packed up in a caſk, or otherwiſe, for ſale.

The END *of the* SECOND VOLUME.

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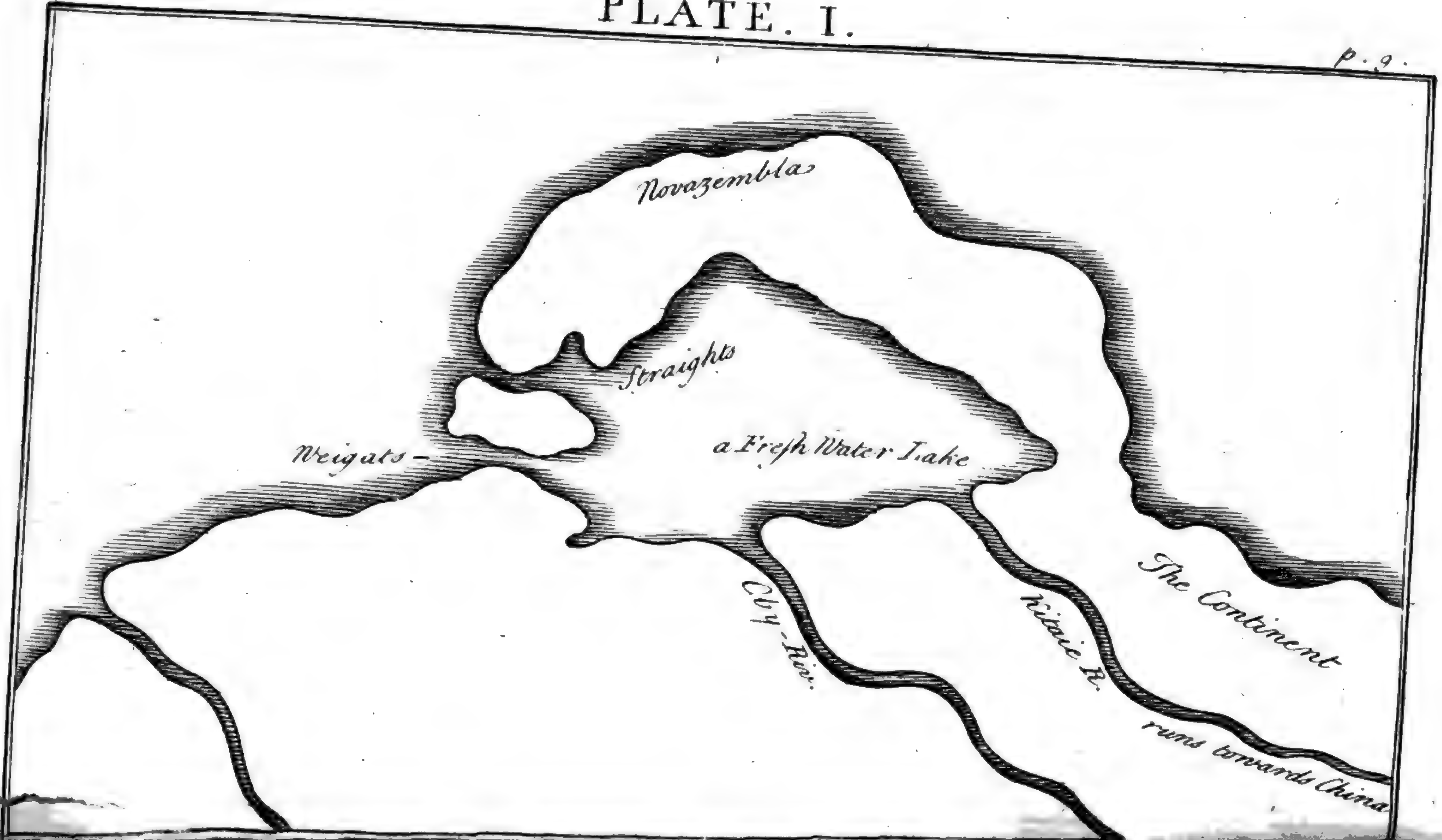
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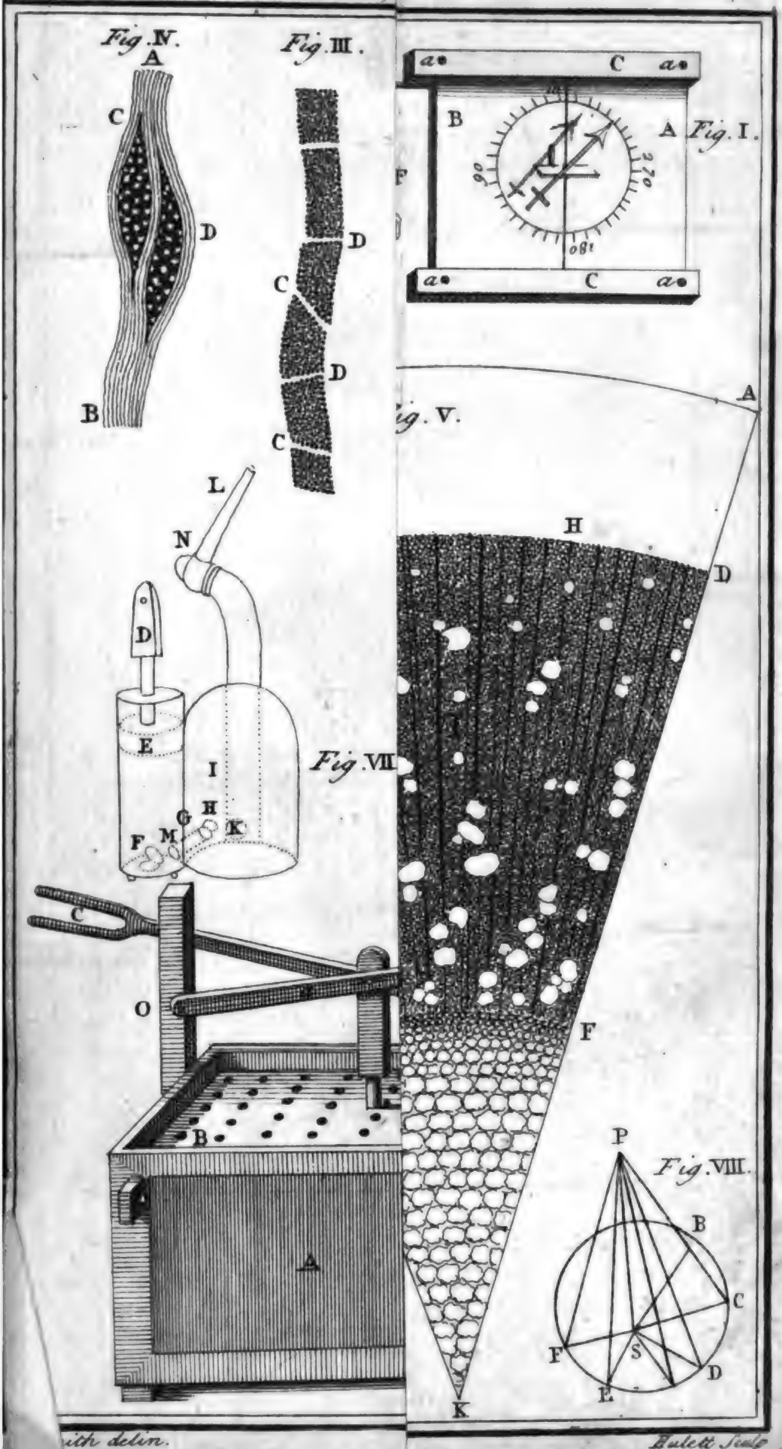
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PLATE. III.

Fig.I.
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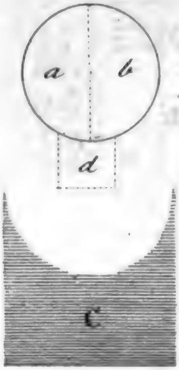

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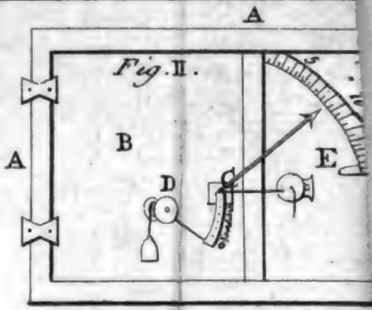

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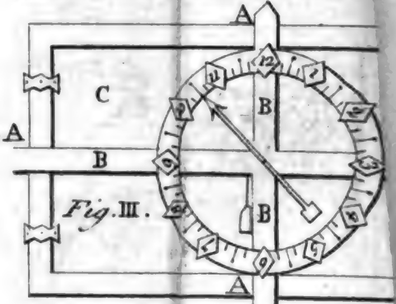
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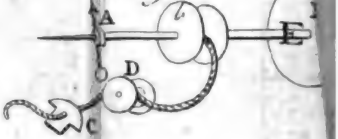

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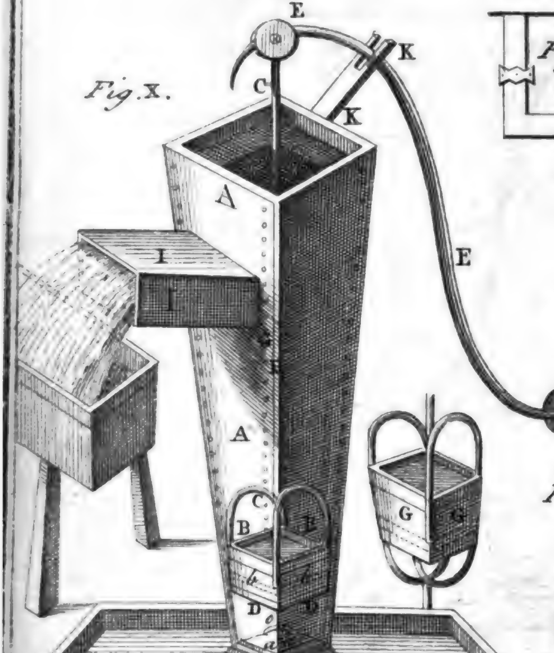
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Fig.XI.

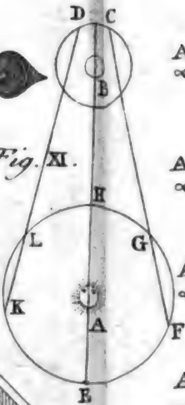
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PLATE. III.

Fig. I.
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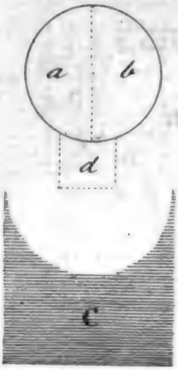

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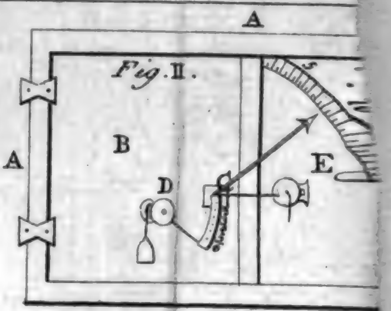

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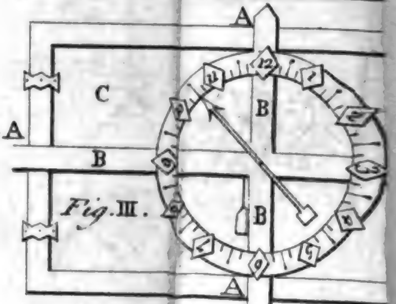
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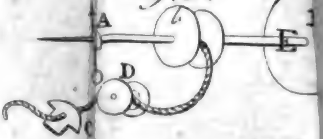

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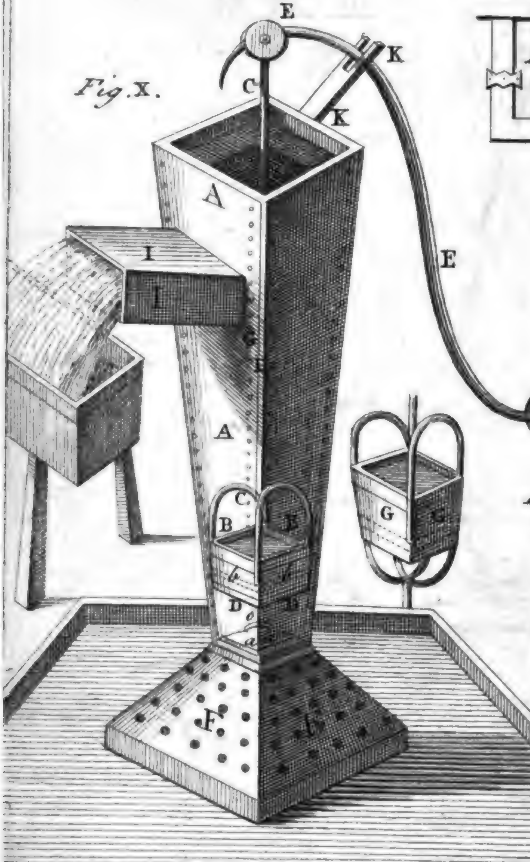
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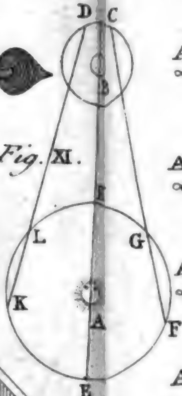
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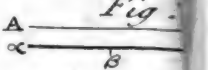

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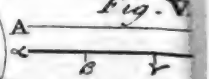

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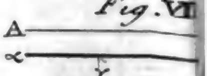

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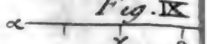

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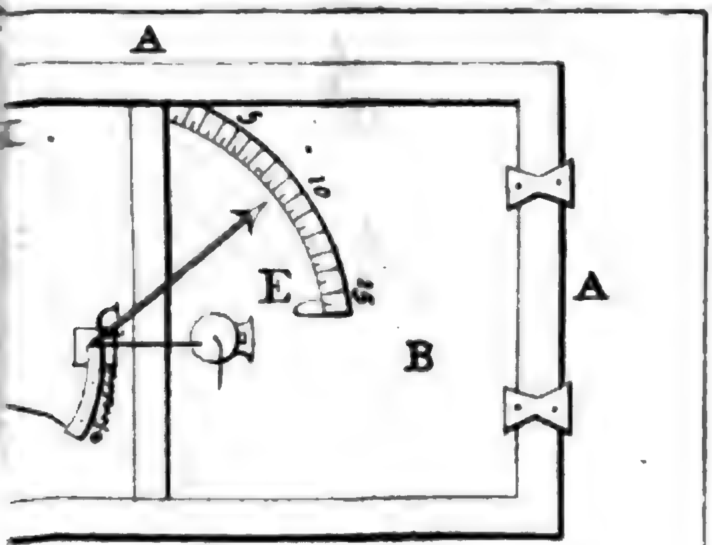

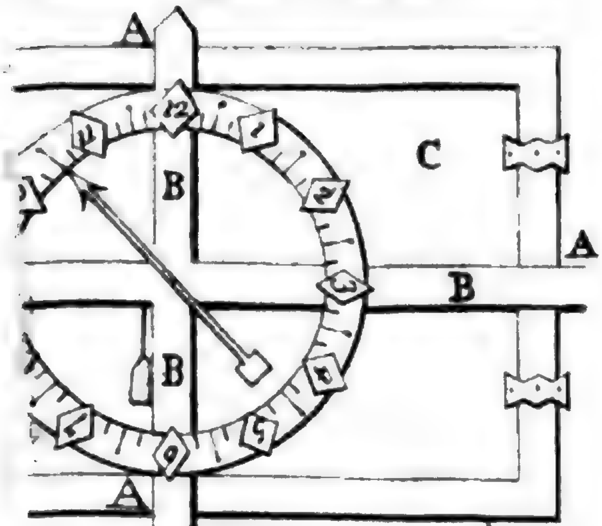
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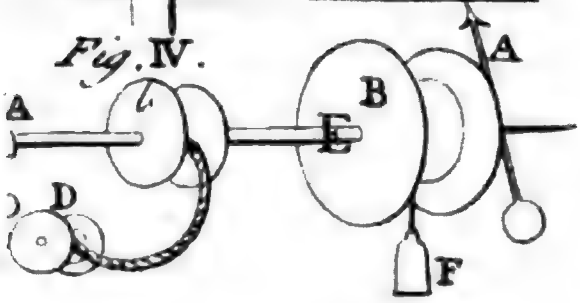

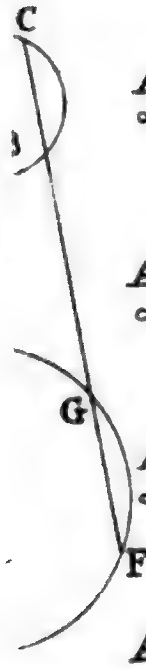

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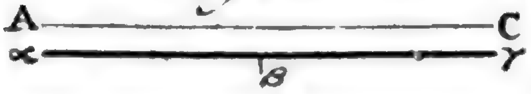

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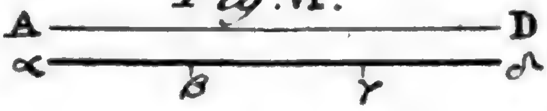

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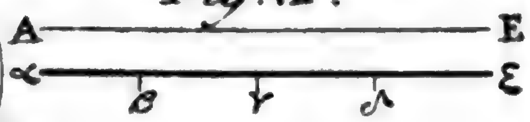

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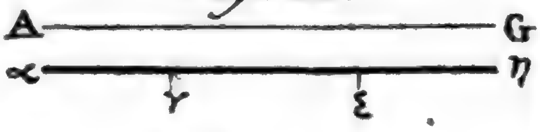

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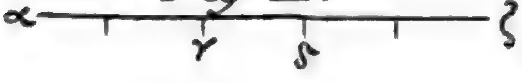

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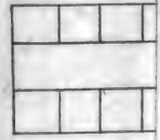

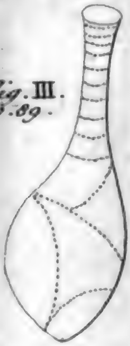

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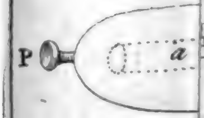

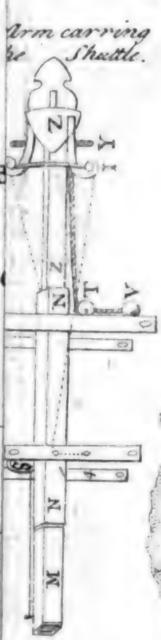

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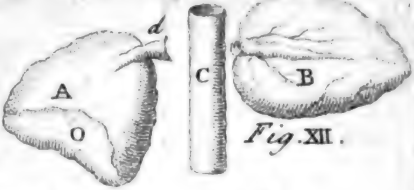

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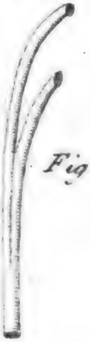

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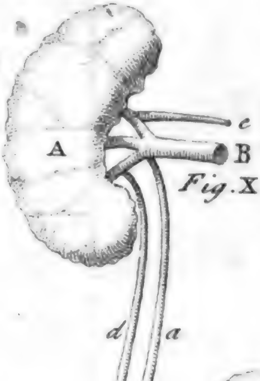

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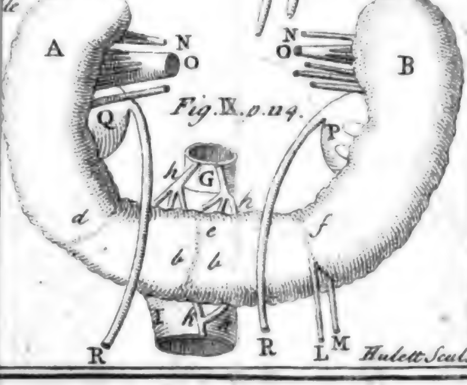

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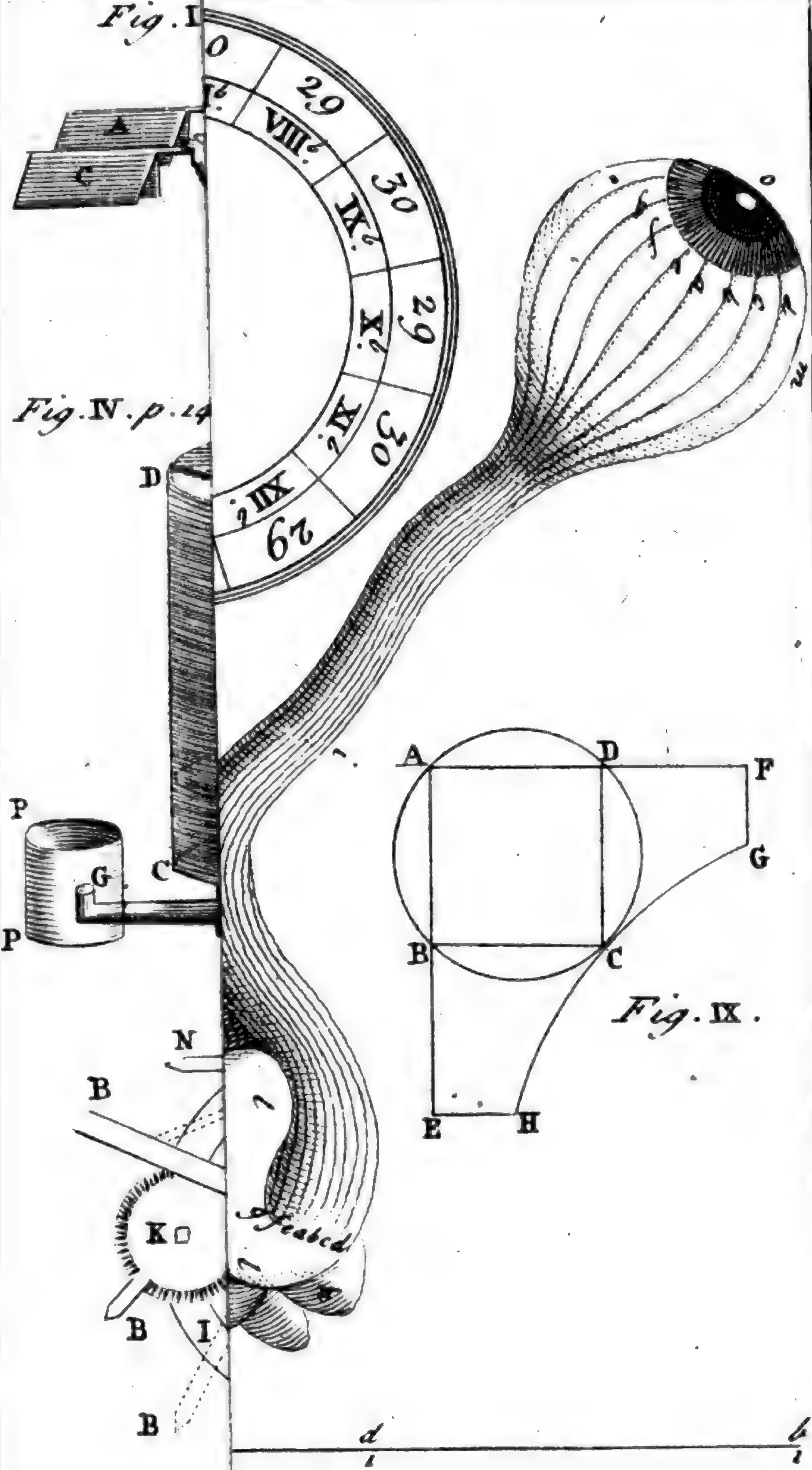

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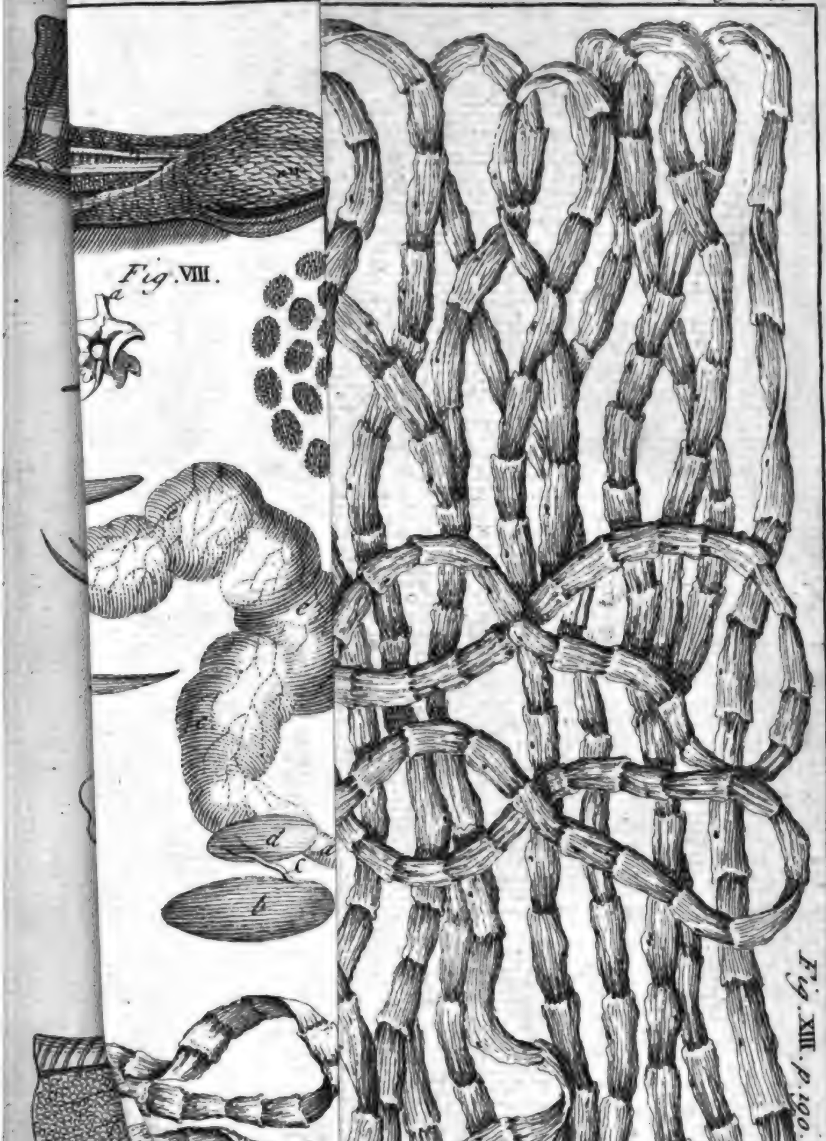
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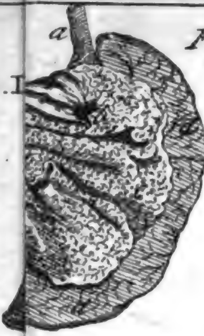

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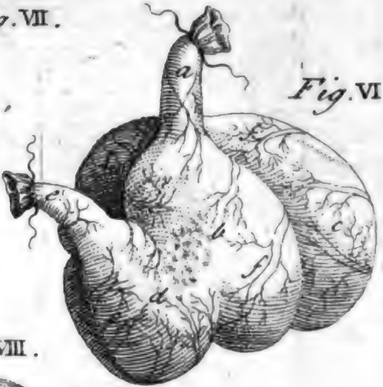

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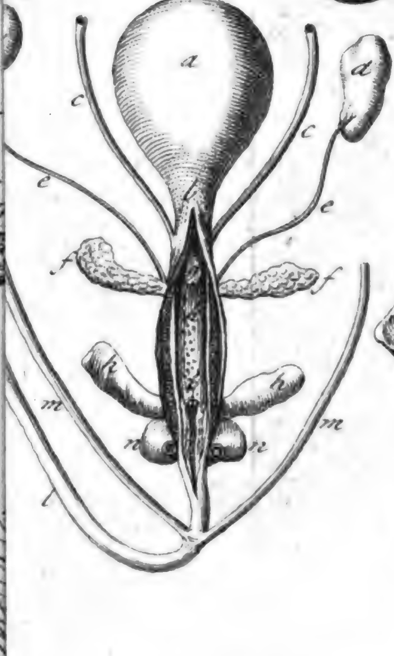
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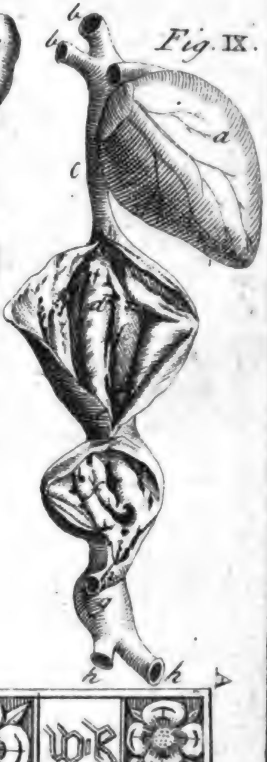

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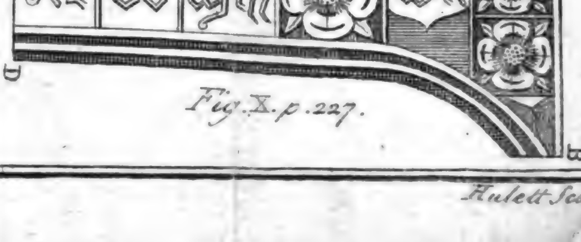
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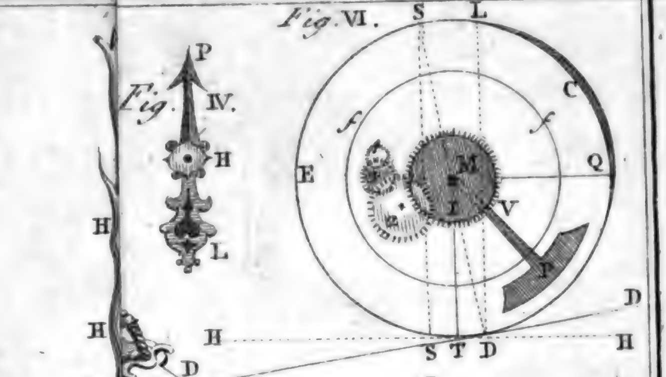
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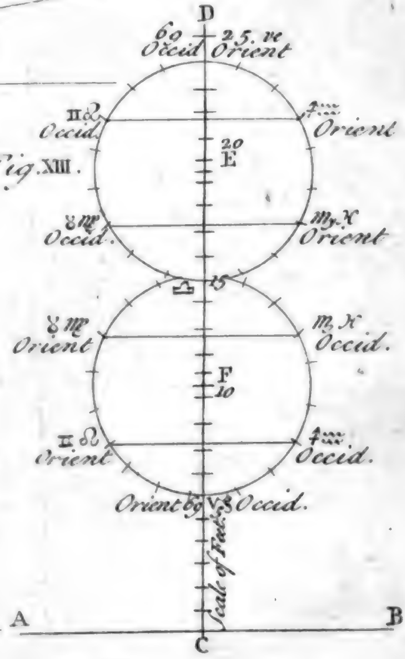
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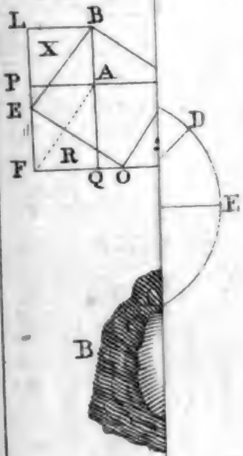
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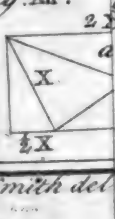
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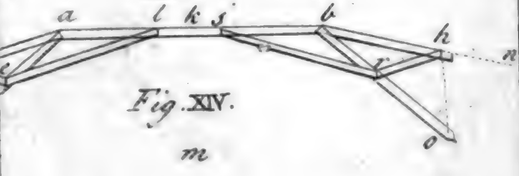
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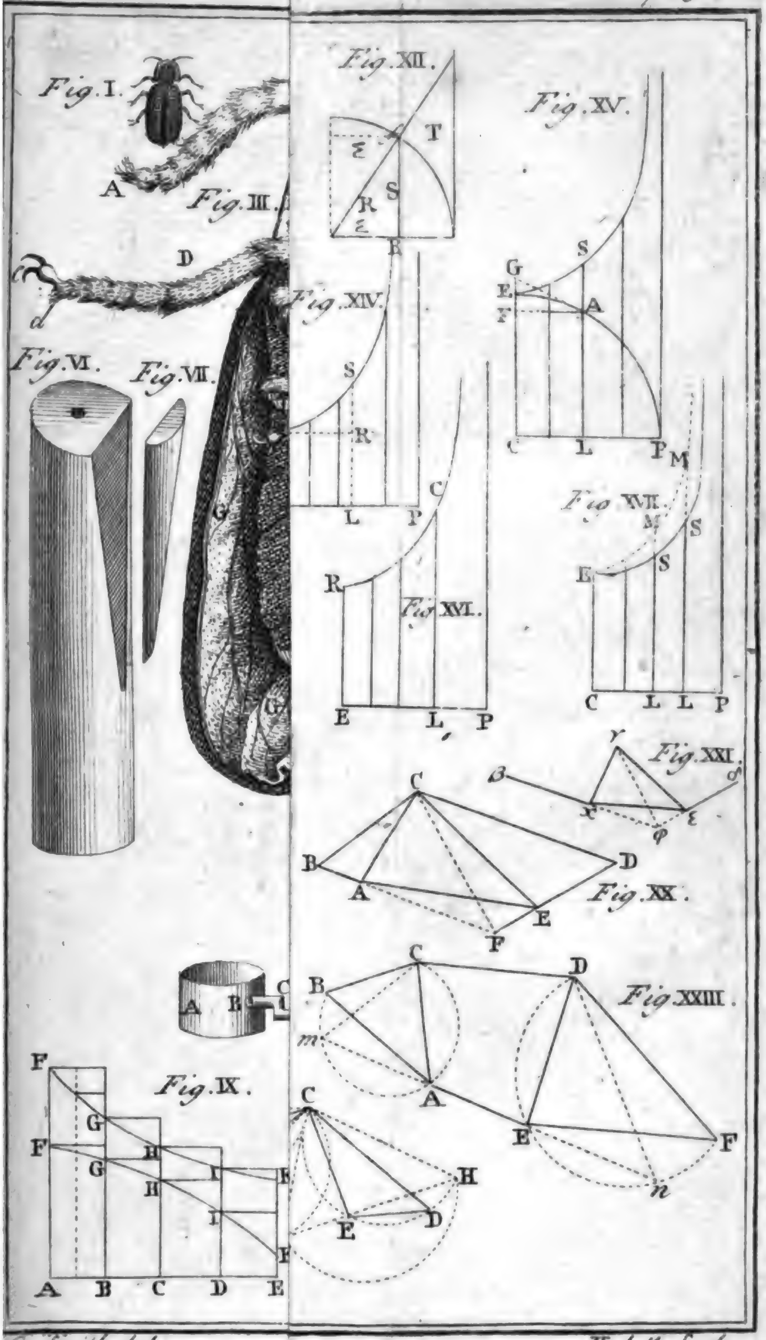
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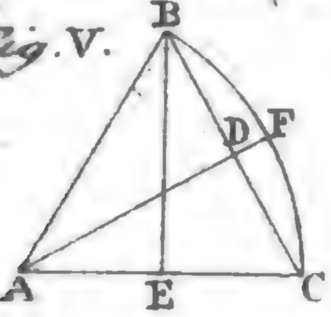

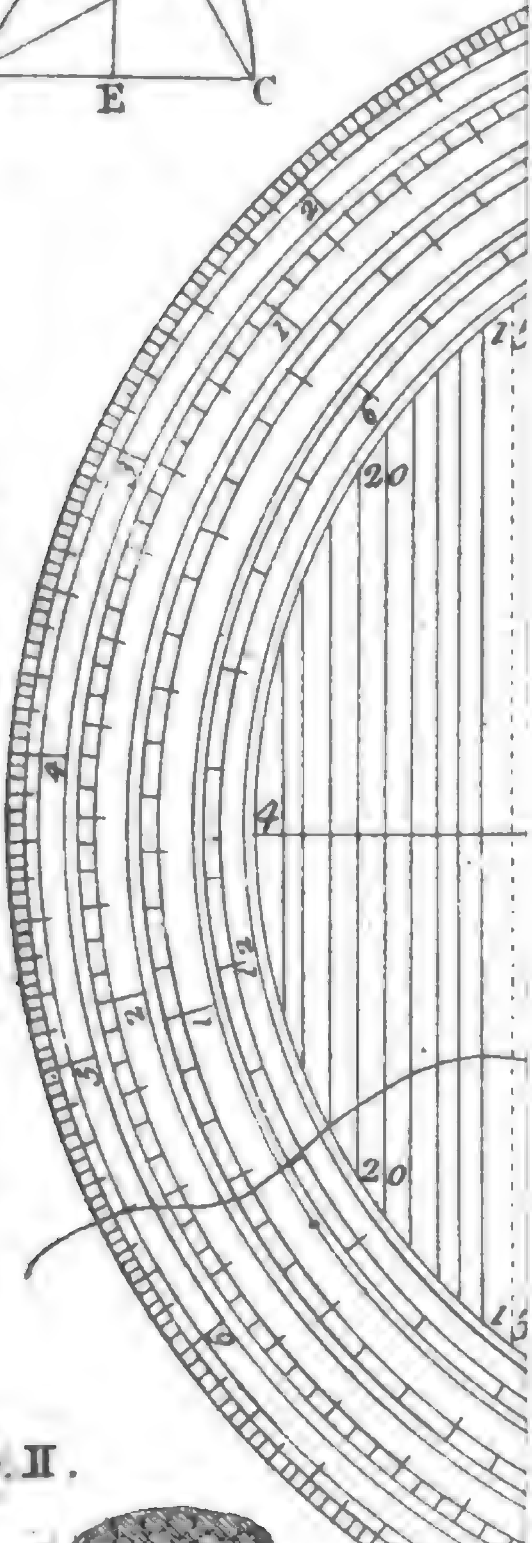
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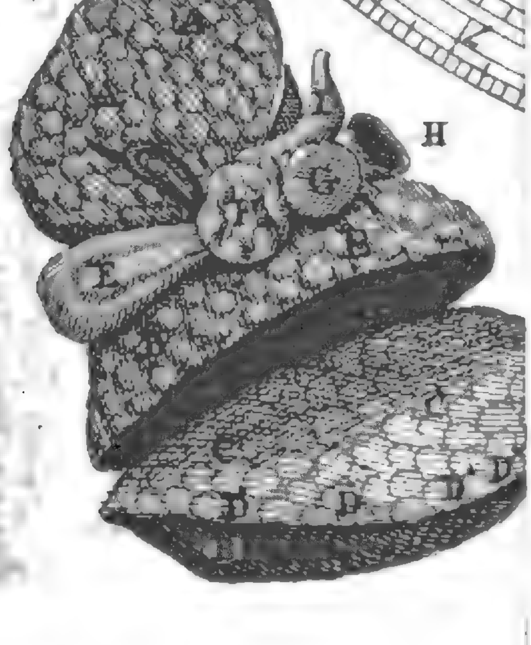
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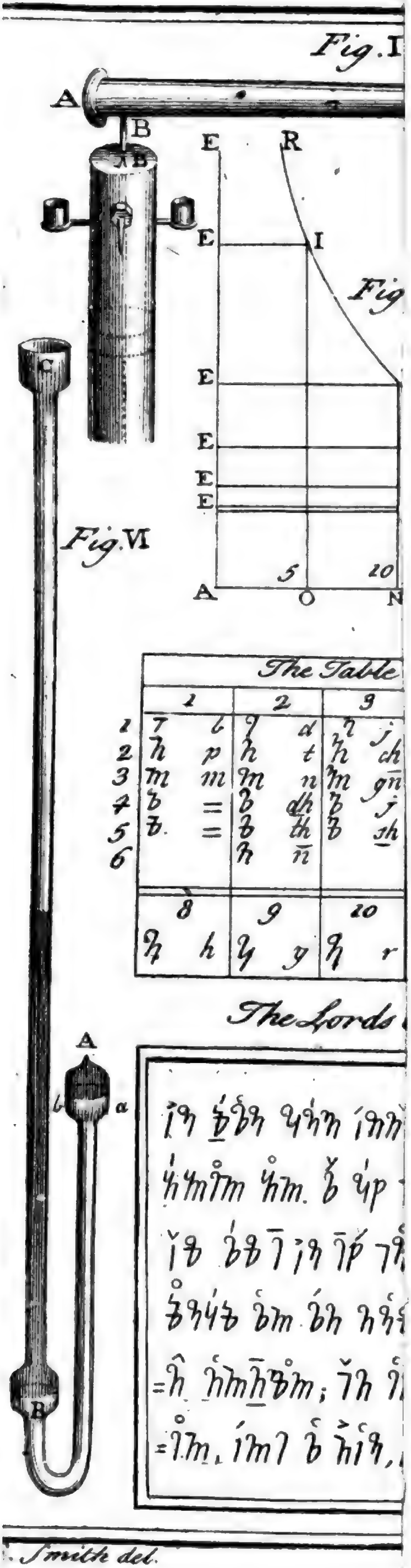
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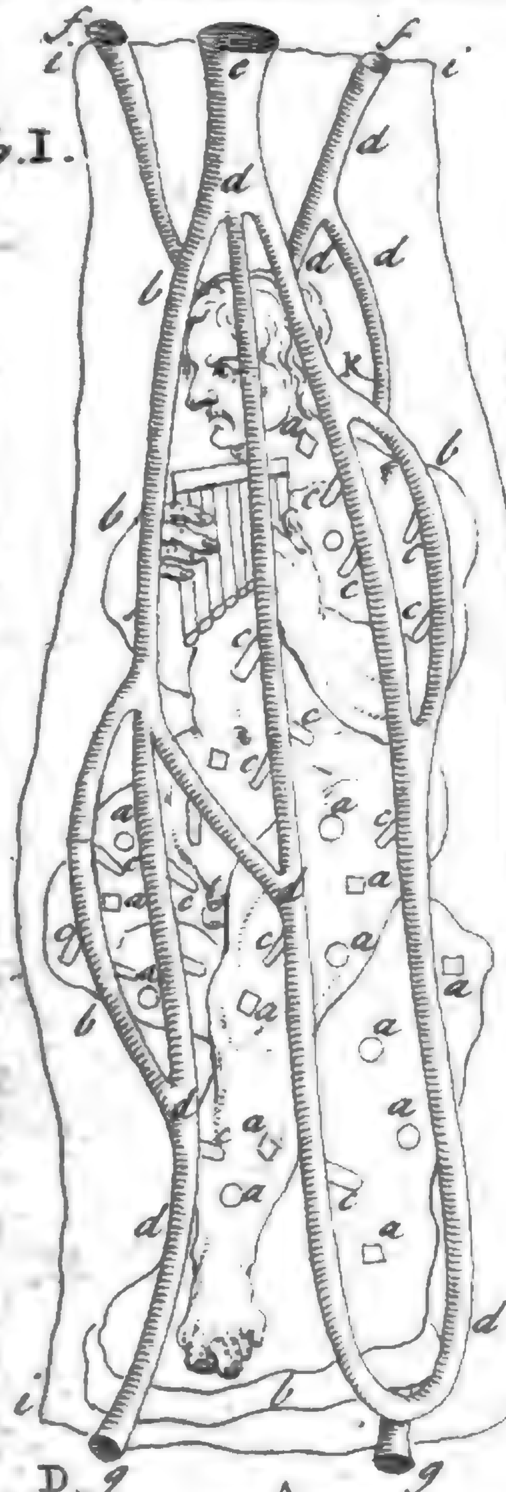
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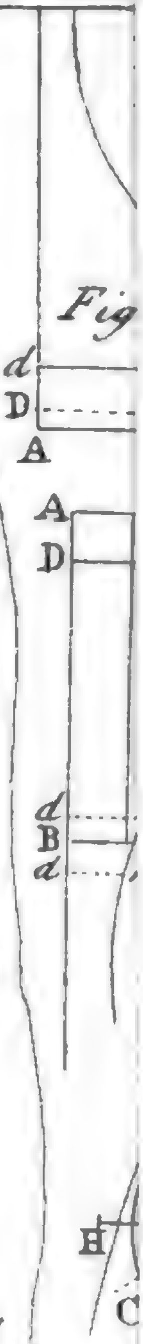
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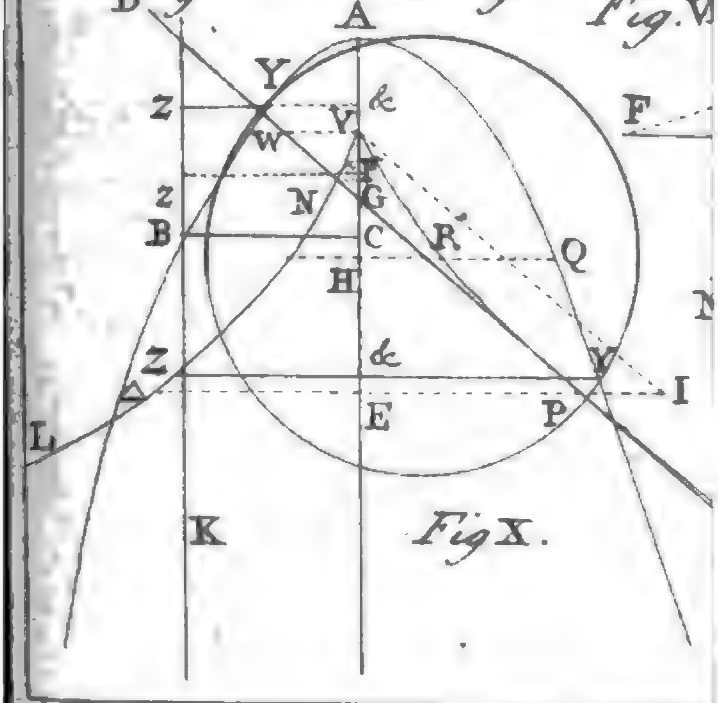
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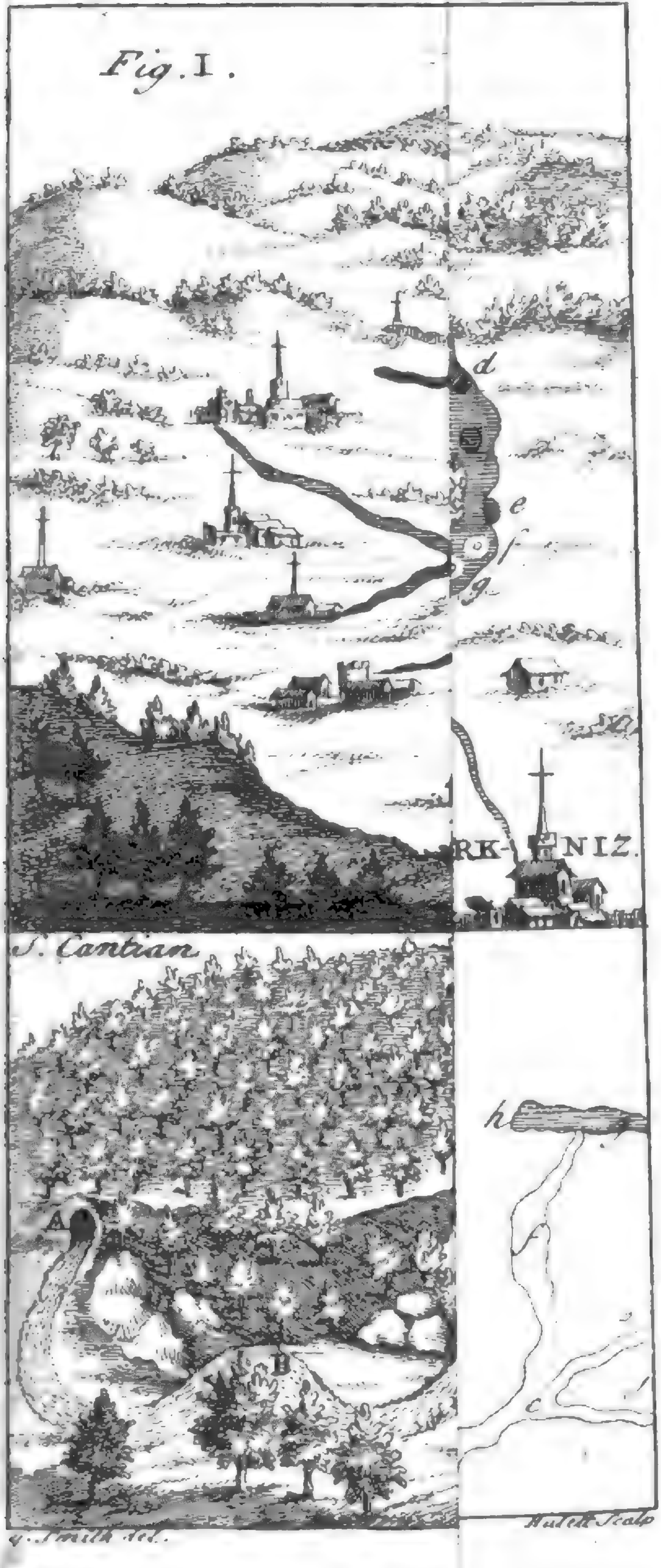
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